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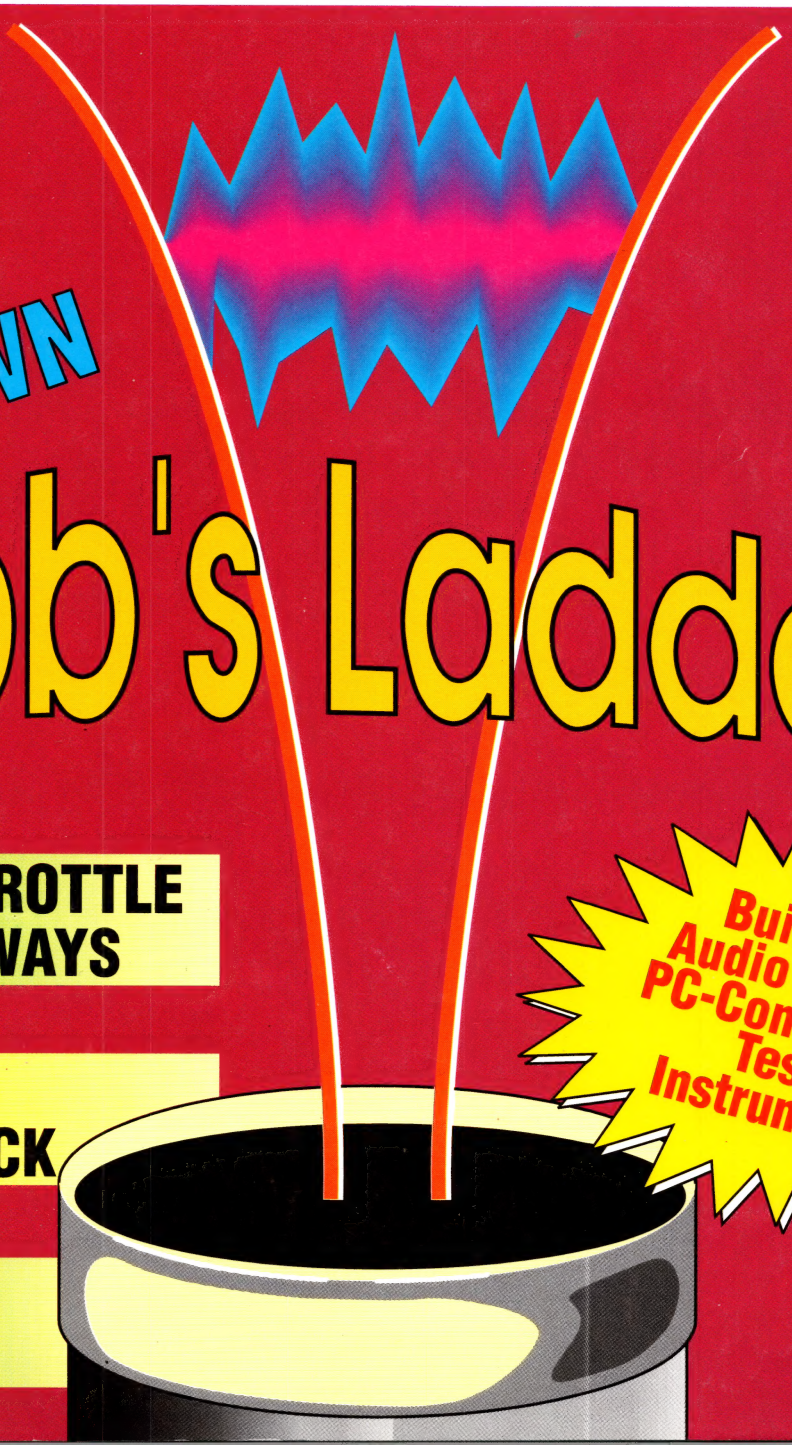

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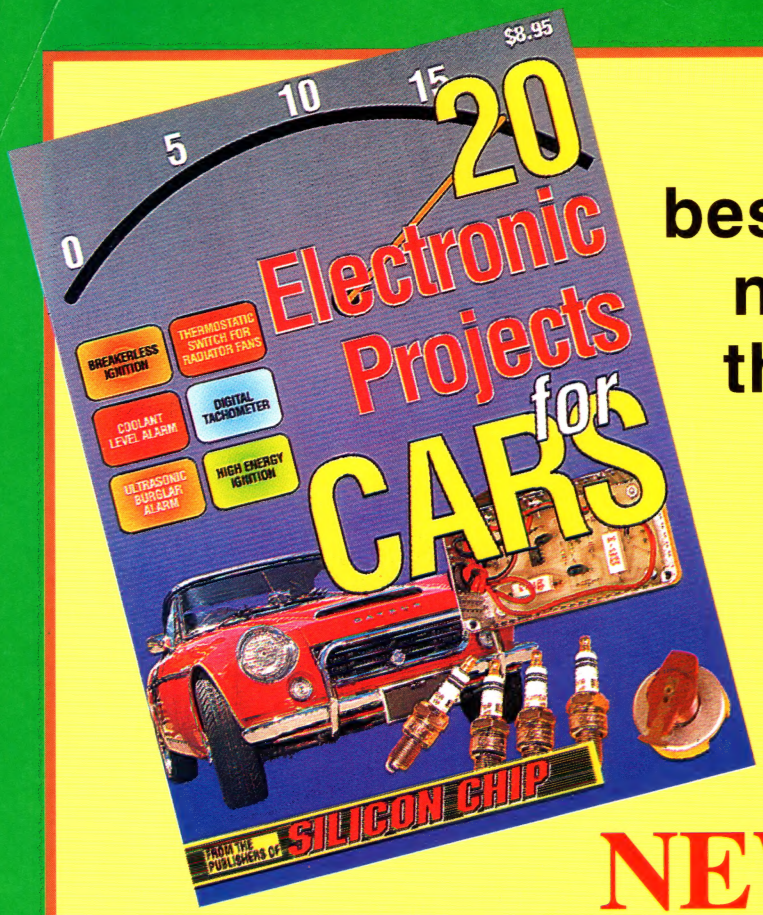

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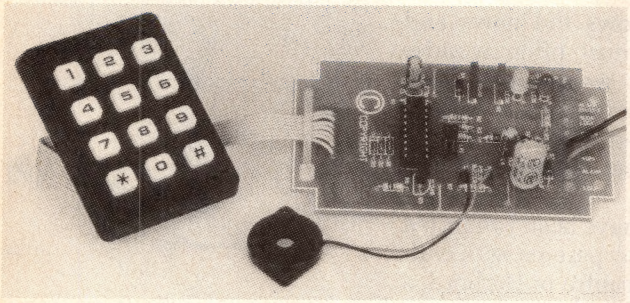

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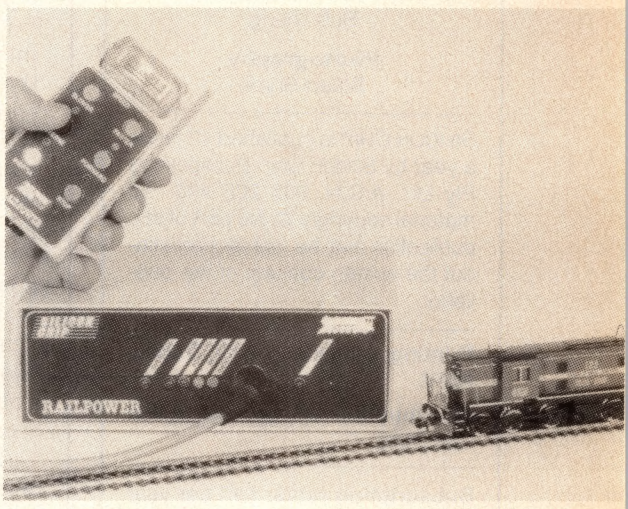

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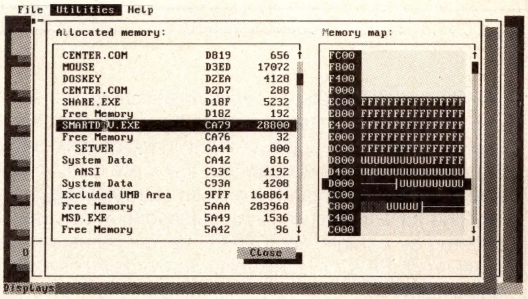

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PUBLISHER'S LETTER

Ignorance & hysteria often carry the day

Anyone who follows the news and people's reactions must often wonder whether Australians really are as keen on new technology as we are made out to be. Often, the reaction is one of fear and loathing, or more precisely, hysteria and ignorance.

These comments have been prompted by the recent action by parents with children at a preschool centre in Harbord, a Sydney beach-side suburb. The parents are reacting against the installation of a cellular phone transmitter tower some 50 metres away from the centre. Predictably, all the local politicians have jumped on the bandwagon and are saying how bad all the "unknown" health risks are and so it goes on. In the middle of all this, Telstra is in a no-win situation. It has legally installed the transmitter site and complied with all the regulations.

Now really, it is about time that such whingeing wimps ceased to get any publicity for their irrational fears and statements. And as for the pollies, they are being hypocritical as usual. You can bet that all politicians and council officials who have made supporting noises for this band of parents will have mobile phones and use them constantly. By doing so, they are subjecting themselves and all around them to much higher RF fields than would be present in the preschool yard. Do they really think there is a risk? I'll bet they have never thought about it at all.

Furthermore, you can bet that some or most of the parents who are so concerned about their little darlings' health risks will have mobile phones as well. Do they refuse to use them in their car when their little darlings are strapped into the back seat? I think not. I'll bet they use them while driving too, a more immediate risk to health. If any of these people really has a concern about the health risks of mobile phones, why do they continue to use them?

The truth of the matter is that no-one likes these cellular phone transmitters because they are ugly. Telstra and the other mobile phone operators would be wise to do some design work to disguise them but apparently that has not occurred to them yet. So in the meantime, we get people whingeing about the health risks. It has to stop. If they honestly thought about the health risks, they would realise that their children are exposed to a far greater risk from running around in the Sun than from any exposure to a cellular phone transmitter. But I doubt that honest thought comes into the process at all. What we are dealing with is ignorance and hysteria and sadly, they often carry the day.

Leo Simpson

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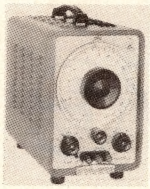

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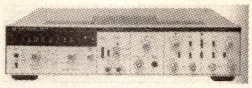

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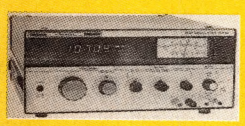

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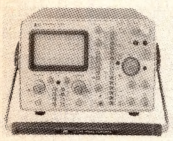

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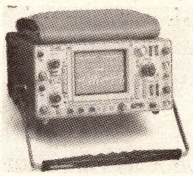

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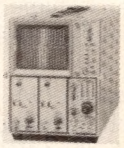

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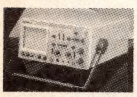

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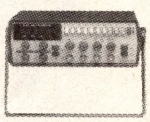

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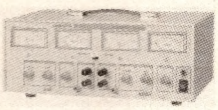

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Pt.1: when to fire the sparkplug

Automotive Ignition Timing

Firing the spark at the right moment is critical when it comes to obtaining good power, emissions and economy from an engine. Here's a rundown on the basics of ignition timing.

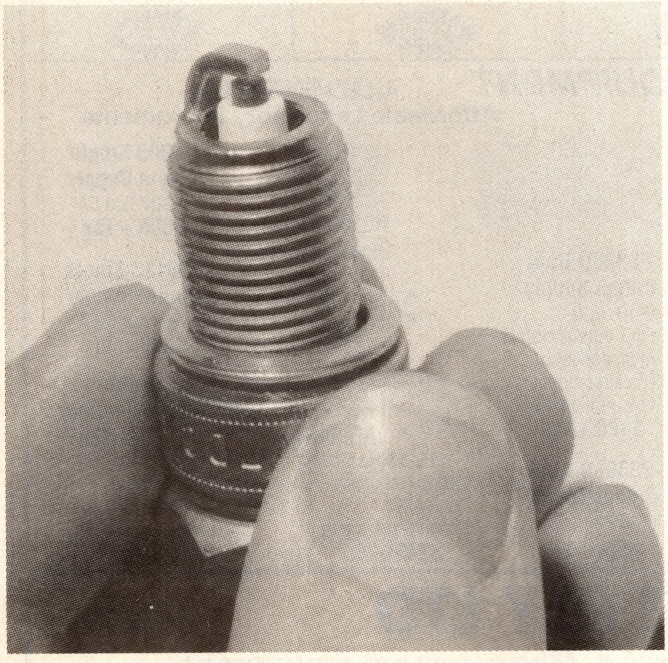
By JULIAN EDGAR

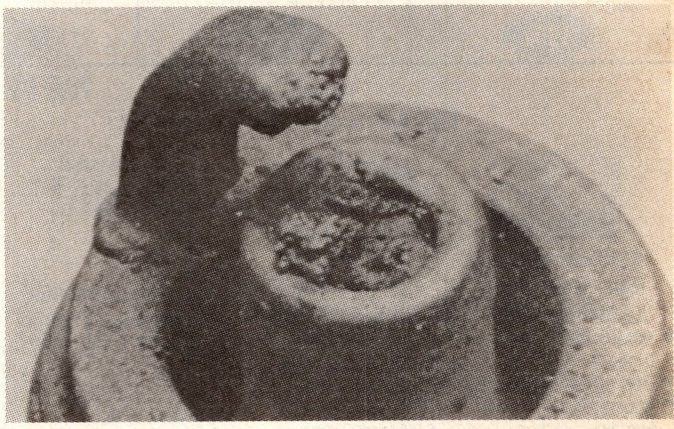
The advent of programmable engine management has meant that people outside major engine manufacturing companies are devising complete ignition advance angle maps for the first time. While the old points-and-weights system may have been modified from time to time, any changes made were always based on the starting point provided by the car's manufacturer. However, when programmable engine management systems can have ignition advance curves of literally any shape programmed into them, a whole new approach needs to be taken.

This month, we examine the factors which influence ignition timing and also look at the traditional spark timing mechanisms. Next month, we will examine the ignition control provided by fully programmable engine management systems and look at the timing maps devised for some specific engines.

While it is obvious that more air and fuel is required at higher engine loads, the same clarity of understanding does not apply to the ignition timing requirements. However, considering the number of factors that affect ignition timing, this isn't surprising.

The requirement for adjustable ignition timing is based mainly on one factor – the finite time taken for the fuel/air charge to be ignited and burned. In practice, the period between the spark firing and the complete combustion of the fuel/air mix is very short – about two milliseconds (2ms) on average. However, while this burn time is small, it is still suffi-





The timing of the ignition sparks during an engine's cycle must be continually adjusted in order to obtain correct combustion behaviour. This, in turn, is necessary for achieving peak power and obtaining low exhaust emissions. Over-advanced ignition timing can cause knocking (or detonation) in the engine. This can destroy the electrodes of the spark plugs (see above) and lead to major engine damage.

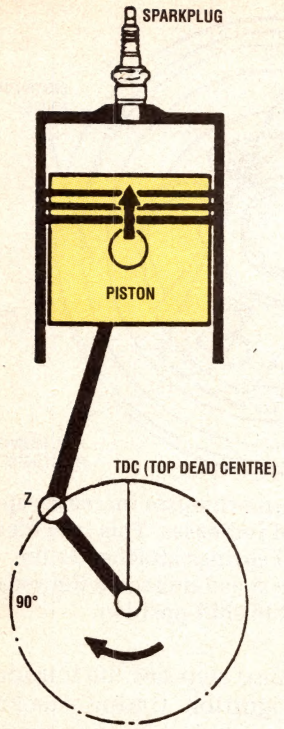


Fig.1: when advanced ignition timing is used, the spark plug is fired before the piston reaches top dead centre (TDC). However, because the combustion takes a finite time, the cylinder pressure peaks after the piston has actually just passed TDC. (Bosch).

ciently long enough to have an impact on when the spark should occur for best performance.

In practice, the ignition must be timed so that the peak pressure caused by the explosion occurs just after the piston has passed top dead centre (TDC), and so is on its way back down the cylinder bore. If ignition occurs too early, then the piston will be slowed in its upward movement. Conversely, if it occurs too late, then the piston will be well down the cylinder and so the work done on it will be reduced.

The timing of the ignition is normally expressed in crankshaft degrees before TDC. For example, if the spark is fired when the crankshaft is 15 degrees before TDC, then the spark timing is referred to as "15 degrees advanced". The greater the ignition advance angle, the earlier the spark is fired while the piston is still heading upwards. Note that in some situations (for example, emissions control), it is beneficial to retard the timing so much that the spark is actually fired after the piston has passed TDC.

If the composition of the mixture was constant (and it isn't), then the elapsed time between ignition and full combustion would remain about the same at all rpm. As a result, if the ignition advance angle was set to a fixed angle before TDC, the combustion process would be shifted further and further into the combustion stroke as the engine speed increased. This is because the piston moves faster at higher engine speeds and thus would be further down the bore by the time combustion actually occurred.

To prevent this from happening, the ignition advance must be progressively increased as engine speed rises (ie, the plug must be fired earlier in the ignition cycle).

The other major factor affecting the amount of advance required is the engine load. As cylinder pressures and the air/fuel ratio decline (ie, the mixture becomes richer), the speed of combustion increases, meaning that ignition should be retarded. Conversely, even more advance than that dictated solely by the engine speed is needed at low loads where lean mixtures are used.

If only it were that simple! Not only does engine speed and load determine the best timing for the combustion of the mixture, but the following factors are also relevant:

(1). the design and size of the combustion chamber;
(2). the position of the ignition spark(s) in the chamber;
(3). the fuel type;
(4). the emissions levels required;
(5). the engine coolant temperature; &
(6). the safety margin required before knocking occurs.

The latter point is of vital importance. Knocking occurs in an engine when the pressure and temperature rises very rapidly due to an over-advanced ignition timing (possibly exacerbated by glowing coke deposits in the cylinder head). Instead of the flame front propagating at about 34 metres/second, it moves at about 10 times this pace, causing a metallic pinging noise to be emitted from the engine.

The noise is of little importance; what is a cause for concern is the damage that this hammer-blow can do to the internal engine components. Broken pistons, smashed heads and shattered sparkplugs can all occur in a just a few seconds.

This problem must be particularly guarded against in engines using forced induction (ie, supercharging or turbocharging). In this type of en-

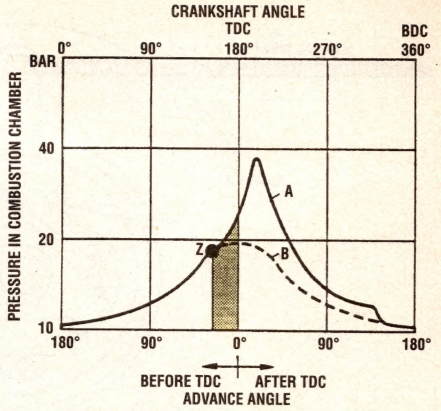


Fig.2: combustion chamber pressure during the compression and power strokes of the engine. The "A" curve indicates the combined compression and combustion pressure, while "B" shows the compression pressure only. "Z" is the point of ignition. (Bosch).

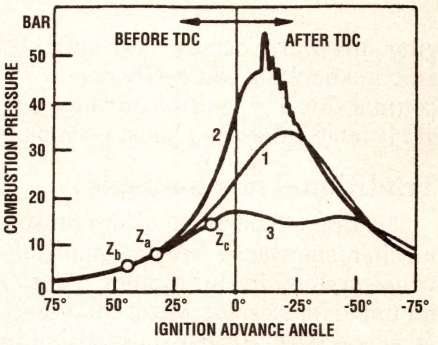


Fig.3: if the spark occurs too early (at Zb), then combustion knock (line 2) will occur. Line 1 shows normal combustion behaviour, the result of ignition at Za. A spark fired too late in the cycle at Zc will result in low combustion pressure as shown by line 3. (Bosch).

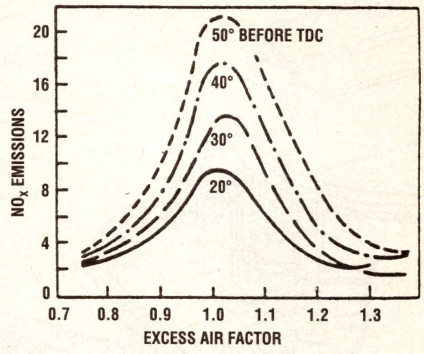


Fig.4: not only is power output affected by ignition timing but also exhaust emissions and fuel economy. The affect of timing on the emission of oxides of nitrogen with different air/fuel ratios is shown here. (Bosch).

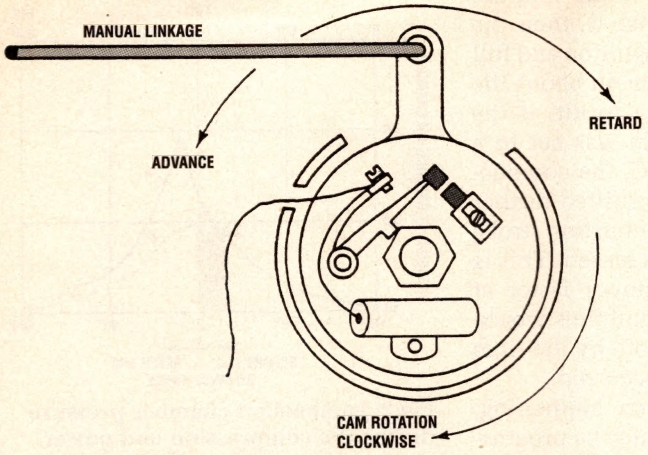


Fig.5: early vehicles used a fully-manual advance/retard mechanism, in which the breaker plate was rotated by the driver by means of a dash-mounted lever. This type of system could provide good control but only if the driver was interested!

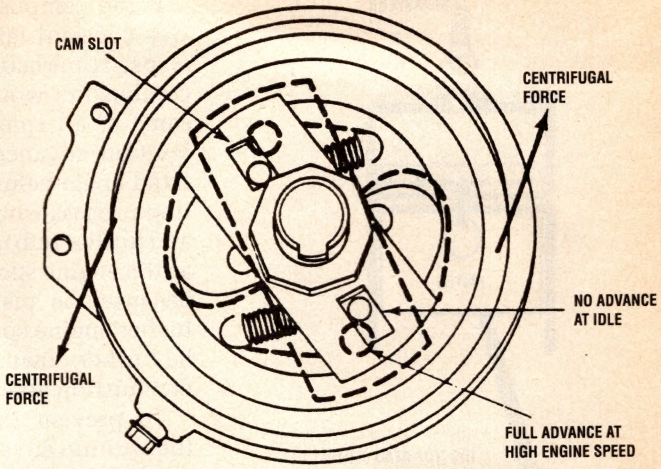


Fig.7: the centrifugal timing mechanism increases spark advance as the engine speed increases. This is achieved by the action of weights and springs attached to the breaker shaft. As the engine speed increases the weights swing out, causing the shaft to shift position.

gine, the burn occurs very quickly and so knocking can easily occur. To counter this, the ignition advance angle is retarded during boost periods.

Traditional mechanisms

The first adjustable ignition timing mechanism was a fully-manual advance system. In this system, a dash-mounted (or steering wheel-mounted) lever was used to rotate the distributor plate. By moving this lever back and forth, the points could be made to open earlier or later in the cycle.

A lever scale allowed the driver to gauge the degree of adjustment. In practice, the timing was normally retarded for starting and then advanced for running. However, although this approach meant that the timing could be fully controlled (with a sensitive driver), its efficiency depended so much on the individual that it was soon abandoned.

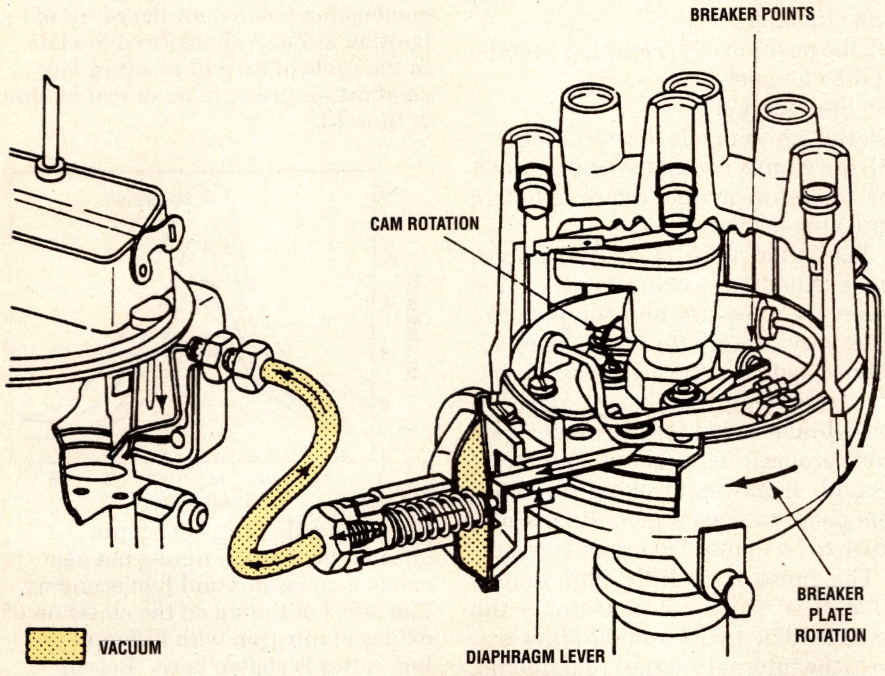


Fig.6: the mechanical spark timing system used until quite recently combines both vacuum and centrifugal advance mechanisms. At times of low load, the manifold vacuum is high and a vacuum diaphragm is used to advance the spark. Conversely, high engine loads result in low vacuum and a relatively retarded spark.

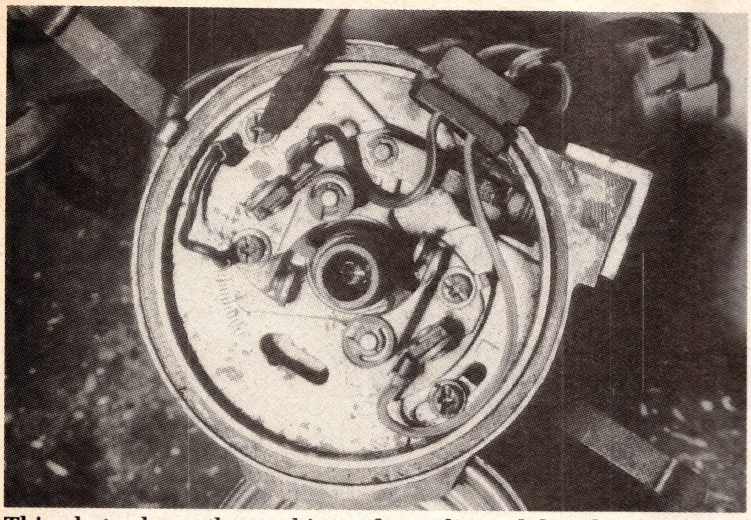
The next step saw the introduction of an ignition timing mechanism which was to last for the next 80-odd years. This system took into account both the engine speed and load using centrifugal advance and vacuum advance mechanisms.

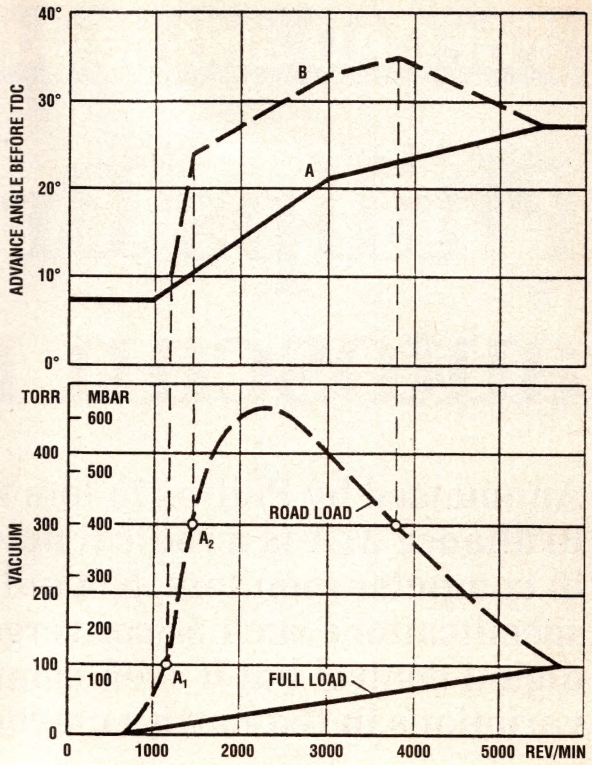
Centrifugal advance was used to change the ignition timing on the basis of the speed of the engine, via a series of spring-loaded weights attached to the breaker shaft within the distributor. As the engine speed increases the weights swing out, causing the shaft to shift position. In turn, this causes the points to open sooner.

Conversely, when the engine slows, the spring-loaded weights retract, allowing the breaker shaft to shift back in the other direction and thus retard the spark.

At the same time, the vacuum advance mechanism is used to adjust the spark timing to suit the engine load. Vacuum advance takes advantage of the fact that when the throttle is only just open, a low pressure (high vacuum) is created in the manifold after the throttle butterfly valve. As the throttle opening increases, the vacuum decreases (a MAP sensor in an EFI system makes use of this parameter to determine engine load).

In vacuum advance ignition timing mechanisms, one side of a diaphragm is linked to the distributor plate by a rod, while the other side is linked pneumatically (ie, via a hose) to a source of manifold vacuum. At times of high vacuum (low load), the distributor plate is turned so that the





This photo shows the workings of a traditional distributor that used points and relied on centrifugal and vacuum advance mechanisms. Fig.8 (right) shows the final timing curve achieved by this type of system. The full-load advance curve (A) is achieved through the centrifugal action of the weights, while the partial load advance curve (B) additionally advances the timing when loads are light (and vacuum is therefore high). "Road load" means that the engine is only partially loaded, while "full load" means that the throttle is wide open. (Bosch).

spark is advanced. Conversely, when the vacuum drops, the spark is retarded in response to the increased load.

Although this primitive system worked well for many years, it did not take into account many of the factors required for optimum ignition timing. Consequently, the safety-margin to detonation (knocking) was generally left high, thereby limiting power and reducing efficiency.

Electronic systems

The use of electronic spark advance systems revolutionised ignition timing. First, the traditional parameters of engine speed and load are now catered for by a detailed timing map stored in an EPROM (electrically programmable read-only memory). An electronic timing map is far more accurate than the timing parameters produced by the traditional mechanical systems and is far more reliable. Many modern cars also now have antiknock sensors and these allow the engine management computer to set the ignition timing for best performance while still maintaining safe operation.

In addition, other factors which affect optimum timing can now be taken into consideration. Typically, a modern computer-controlled engine management system accepts data from sensors which monitor engine speed, manifold vacuum, throttle position, engine temperature, air temperature and battery voltage, and sets the ignition timing accordingly. Such systems also usually provide full fuel management as well, by controlling the fuel injectors.

As a result, electronic engine management systems provide improved starting and idle speed control, better fuel economy, increased performance and lower engine emissions. **SC**

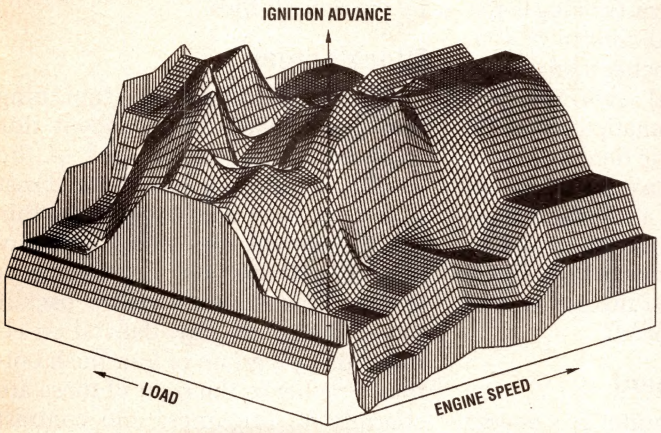


Fig.9: electronic spark advance and engine management systems allow complex ignition maps which provide optimal timing for a large range of load and engine speed conditions. (Bosch).

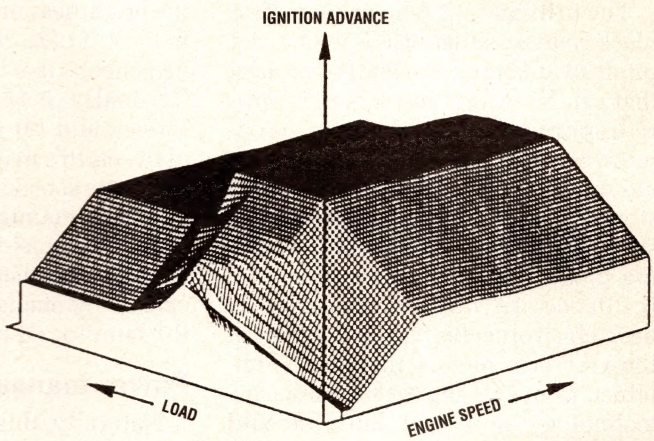


Fig.10: the traditional mechanical advance mechanism produces a map which is far simpler than that achieved by electronic means. As a result, the ignition timing is far from optimum in many operating conditions. (Bosch).

For CAD and desktop publishing

Philips Brilliance 21A autoscan monitor

Announced by Philips in late 1994, the Brilliance 21A is a radical new development in computer monitors. Not only are all its specifications such as convergence under digital control but it even compensates for variations in the Earth's magnetic field.

By BOB FLYNN

Ever since this new range of monitors was released, they have been in short supply but after a very long wait, we finally received a sample unit to review. It was quite an experience.

We have a number of large screen monitors in the SILICON CHIP offices but for sheer size, the Brilliance 21A monitor puts them in the shade. It's not so much that it has a large screen but its cabinet is quite bulky and heavy. Its overall dimensions are 528 x 540 x 501mm (W x H x D). So you need a large desk for one of these monitors and you need two men to lift it safely since it weighs 37 kilograms.

The Brilliance 21A has a 54cm, flat, black matrix, square CRT with a dot pitch of 0.28mm, currently the best that can be made. The screen is anti-reflection and antistatic treated. Maximum resolution is 1600 x 1280 pixels although that does not tell the whole story. While many monitors can be switched to 1600 x 1280, their resulting picture may not be useable. The Brilliance 21A, on the other hand, has been electronically tweaked to obtain the very best picture that can be obtained from existing 0.28mm dot CRT technology. In fact, it could be said the picture quality is theoretically better than is possible. We'll see why, later.

As with all large screen monitors, the Brilliance is an autoscan model and will automatically cope with horizontal scan rates from 30-82kHz and vertical scan rates from 50-160Hz. Video input is RGB analog and typical sensitivity is 0.7V. Video bandwidth is 150MHz and input impedance 75 ohms. Three modes of sync are accepted: composite sync on the green line, separate composite TTL sync (positive or negative) and separate TTL Horizontal and Vertical sync (positive or negative).

The monitor also has the following features: (1) digital control of contrast and brightness over the full screen, the brightness uniformity being better than 90%; (2) digital control of convergence so that it is better than 0.2mm (typically 0.15mm) over the full screen; and (3) automatic cancelling of the earth's magnetic field through a magnetic sensor and a proprietary circuit that maintains a constant magnetic field inside the monitor. This ensures that distortions of the display caused by changes of the position of the monitor do not occur.

Power management

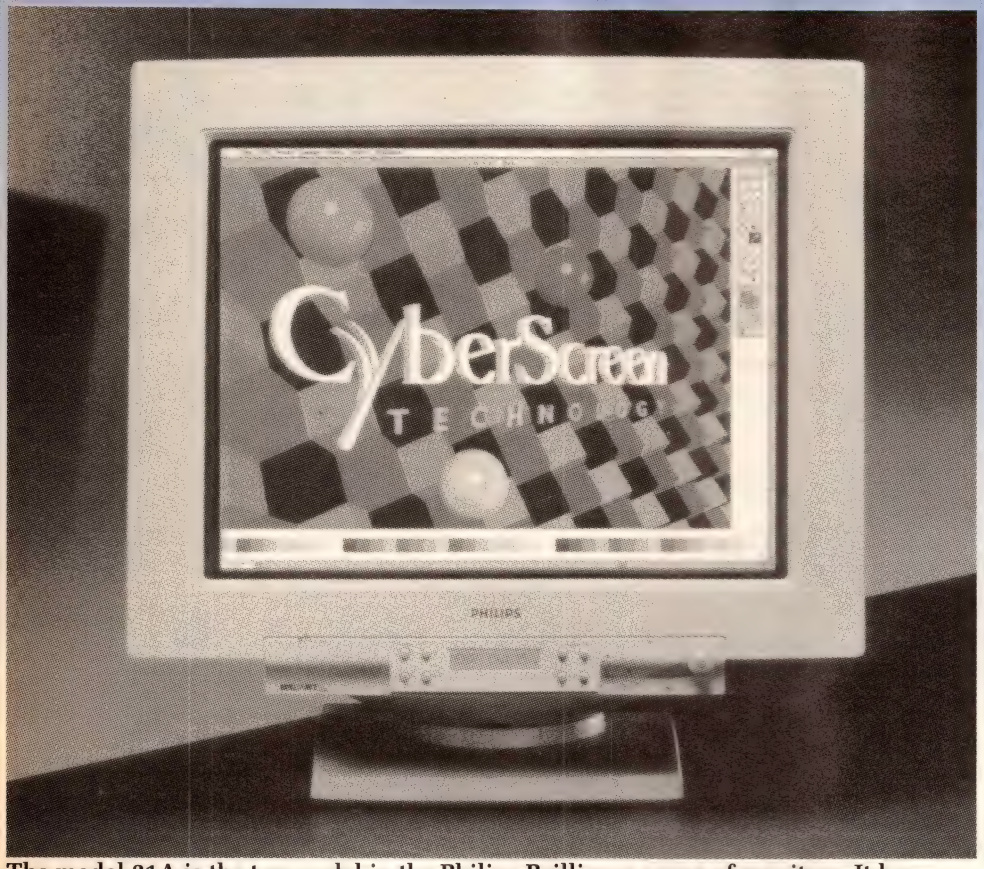
Naturally, this monitor has energy saving features and they are quite comprehensive. It is TCO 1992 Power Management/Energy Star Power Management compatible. This requires a VESA-DPMS compliant signal. With screen saver programs, the power consumption drops 10%. With computers with VESA Display Power Management, the power consumption drops from a maximum of 180W to 15W, after one hour without vertical and horizontal sync signals. When sync signals are restored, recovery to normal operation takes less than 3 seconds. After a further one hour without sync signals, the monitor switches to its lowest power state, consuming a maximum of 8W. Recovery time from this state is the same as the normal switch-on period. The power state in these reduced modes is shown on the LCD panel.

Storage in the monitor's memory of 21 different graphic resolution files, 12 factory preset and nine user generated, is possible. Software is supplied with the monitor that allows the user to adjust the image for the correct size and centring and generate a correction table for the control of convergence, brightness and colour uniformity, if the application is not covered by the default files.

Black screen

Apart from the size, the first thing that most people notice about this monitor is the "blackness" of the screen. It certainly has the blackest screen we have seen. Apart from this the 21A looks very much like any other digital monitor. At the bottom centre of the front is a yellow backlit liquid crystal display, flanked on either side by a group of four push buttons. Further to the right of these are controls for brightness and contrast and the power switch.

The buttons to the left of the display are Function, Adjust (+), Degauss and Adjust (-). The + and - buttons



The model 21A is the top model in the Philips Brilliance range of monitors. It has digital control of all picture parameters and automatic compensation for variations in external magnetic fields.

each allow adjustment of the geometry and colour temperature through a scale of 0-9, indicated on the LCD. The buttons to the right of the display are Memory Select, Memory Store, Memory Recall and Input select.

Pressing the Function button accesses the following 10 functions sequentially: Horizontal position, Width, Vertical position, Height, Colour temperature, Pincushion, Pincushion balance, Trapezoidal, Trapezoidal balance and Language.

The colour temperature function allows the choice of either a 9300° or 6500° white. A third choice allows the operator to set his own colour temperature by the adjustment of the red, green and blue mixture using the + and - pushbuttons.

On the rear of the monitor is a power input socket (the monitor can operate from 90-132VAC and 180-264VAC, 47-76Hz auto selected) and five BNC sockets for the signal connections. A 15-pin Mini D-Sub socket for video input is also provided. A socket not normally found on monitors is 9-pin Mini D to provide a serial interface between the computer and the monitor's own internal microprocessor. A two-position slide switch selects either 75-ohm input impedance or high impedance. With only one monitor connected to your computer this switch should be in the 75-ohm position. The high impedance position should only be used if two monitors are connected to your graphics card.

At switch-on the LCD panel displays the message "Wait...start up", followed by "F/W Release..(No.)". Each of these messages display for 1-2 seconds and are then followed by the message "Test in progress". This message is displayed for 2-3 seconds while the monitor does its self checks. If the monitor recognises the timing supplied by your video card as one of its default modes the LCD will show the resolution being used. If it does not, then the message "Mode not found" will be displayed.

This means that the current timing is not stored though the monitor is working, with a proper screen display. You can elect to ignore the "Mode not found" message but if you do you will not be able to optimise the convergence for your mode. Hence, you need to store your mode by pushing the channel select button to select one of the user file memories (13-21).

Error messages

If no connection can be made between the monitor and your computer, the LCD will display an error message such as "Missing H sync", "Missing V sync" or "Missing H & V sync", meaning that cables are improperly connected or the computer is not switched on. The messages "V out of range" or "H out of range" mean that the vertical or horizontal scan frequencies of your computer are outside the monitor's 50-160Hz vertical or 30-82kHz horizontal scan rates. Five additional error messages may be displayed to indicate monitor faults.

Geometry & convergence

For our tests, the Brilliance 21A was connected to a 486DX and used with programs operating at various resolutions from 800 x 600 to 1280 x 1024 pixels. For the two highest resolutions, the message "Mode not found" was displayed and so we went through the procedure for creating user generated files. The supplied software runs from Windows and involves linking selected channels to user tables. This done, Geometry Adjust was carried out. This entails adjusting the raster to screen centre and setting the vertical and horizontal borders to a width depending on the resolution for which the table was being made.

The next step is to Select Reference Points. A green mark has to be moved to the top left of the screen and a second green mark moved to the bottom right of the screen. The program then creates the correction table for brightness and convergence of the operating mode. The files so created should be saved to the hard disc so that the channel settings can be restored if required at a later date.

Why do all this? Because the Philips Brilliance 21A is capable of much better convergence than typical computer monitors but it has to be done for each and every screen resolution and combination of horizontal and vertical sync. With such a large screen and fine dot pitch, picture imperfections

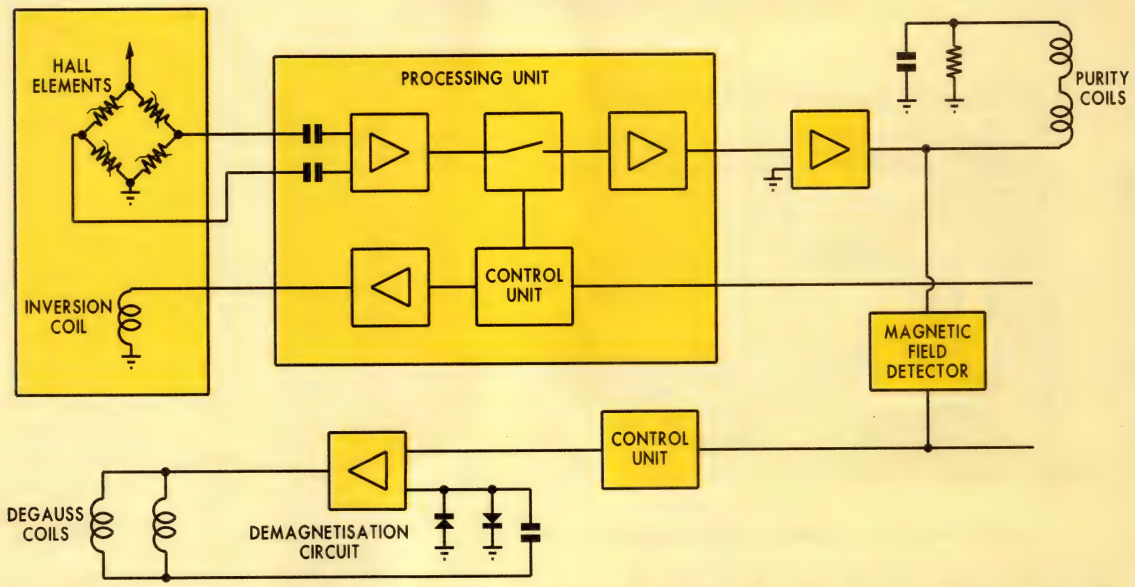


Fig.1: the schematic of the magnetic compensation circuitry in the Philips Brilliance 21A monitor. It continuously compensates for any variations in external magnetic fields and ensures that optimum picture quality is maintained.

that would go unnoticed on smaller monitors become critical, particularly at the higher screen resolutions.

Magnetic field compensation

All of the fine attention to detail in obtaining the best convergence, geometry and uniformity of screen brightness are subject to a big hazard in the larger monitors. Simply rotating the monitor changes its orientation to the Earth's magnetic field and thus the electronic beams scanning the picture are thrown off their optimised paths. This happens in all monitors but again, the larger the monitor, the worse the effect on the picture, especially as far as purity is concerned.

Philips has been really clever here in introducing their innovative Cyberscreen Technology, a high falutin' name which embraces all the 21A's digital control circuitry and, more particularly, its magnetic field compensation.

In essence, the 21A monitors the magnetic fields acting upon the monitor and then produces a compensating magnetic field so that the high convergence standard is constantly maintained.

The schematic of Fig.1 shows the general arrangement. A bridge of Hall Effect devices is used to monitor the magnetic fields and produce an offset voltage. This voltage is converted to a square wave by alternating current pulses fed to the inversion coil. The output square wave's amplitude is proportional to the magnetic field strength. The square wave is AC coupled to the processing unit to remove the offset and amplified. The signal is then applied to the purity coils to correct the monitor's convergence – a classic feedback circuit.

The correction signal is also rectified to produce a DC voltage proportional to the magnetic field. This voltage is applied to the degauss circuit where any change in level triggers the degauss circuit. Hence, at any time, the Brilliance 21A may perform an automatic degauss which you see as a momentary picture distortion accompanied by the characteristic audible twitch from the degauss coils.

The proof of the pudding

While it is easy to be overwhelmed by the complexity of this monitor and its operating procedures, the proof is in the outstanding picture quality. The monitor was used mainly with a CAD program at a resolution of 1280 x 1024 pixels and the display showed excellent geometry, even brightness and good resolution. With my usual monitor (a 20-inch colour monitor with 0.31mm dot pitch), I need to zoom in frequently on large drawings, particularly when placing type; circles that appear round at the centre of the screen are not so when moved away from centre. This is not the case with the 21A. Type placement does not require the same level of zoom and circles are circles no matter where they are placed on the screen. As noted above, high resolution mode in one monitor is not the same as on another and this is where you really notice the picture quality of the Brilliance 21A – it is aptly named.

A minor irritation is the delay that occurs when the resolution changes within a program. For example, if the program shells out to DOS, to perform a print command, then the monitor takes a noticeable time to find the correct resolution file and show a correctly scanned picture. This delay is longer than the switching time of the relays in a multi-sync monitor.

As well as being ideal for desktop publishing and CAD programs, the Brilliance 21A would appear to be ideally suited to any program where colour accuracy is paramount such as in advertising production, textile and fashion design, and so on.

At the time of writing, the Philips Brilliance 21A is priced at $5270 plus tax where applicable. Further information can be obtained from Philips Business Electronics, Technology Park, 3 Figtree Drive, Homebush, NSW 2140. Phone 1 800 658 086. **SC**

MAILBAG

Two project suggestions

I would like to suggest two ideas for future projects. The first is a low power, say 5W maximum, general purpose stereo amplifier. I recently repaired a cheap 3-in-1 which was suffering from severe distortion from one channel. It turned out that the audio chip was (a) dead and (b) obsolete.

I replaced the chip with the Mini Stereo Amplifier kit from the Dick Smith Funway series, as it was the only small stereo amplifier available. The LM380s are only good for around 2W flat out (if you don't mind 10% distortion!) and can be unstable little mongrels when they want to be. There must be a suitable stereo chip lurking in the data books somewhere that could be useful as a slightly higher power general purpose amplifier.

The second is slightly more unusual – a replacement for the spark start system in a gas stove. I was visiting a relative recently who is badly affected by arthritis and found her struggling with matches to light the gas because the electric start system in the stove had given up the ghost.

After whipping the back off the stove, the spark unit turned out to be a black box, about the size of an average sized jiffy box, with six wires, for the six jets and run from the 240VAC supply. Unfortunately, it was sealed in epoxy plastic which made repair impossible. This was the second unit that had failed and she did not want to bear the expense of another service call, for it to fail again. The length of the spark would not have to be too large, say 5mm, but it should have separate outputs in case one of the outputs is shorted to earth accidentally.

M. Allen,
Artarmon, NSW.

Comment: a suitable low cost amplifier is the LM1875T module featured in the December 1993 issue. While capable of 25W it can be derated to deliver 4W with a 20V supply rail.

The best approach to reliable gas lighting (particularly with natural gas) is to dispense with the electronic spark units altogether and to use a gas lighter designed for the job. One such unit, branded "Red Head" is a modified cigarette lighter with a long nozzle. They sell quite cheaply, for just a few dollars.

Disappointment with speaker review

I am writing to express my disappointment of the quality of the review of the Jamo classic speakers by Leo Simpson in the July 1995 issue. It reads more like a paid advertorial and forum for personal opinion rather than a clear unbiased technical and subjective evaluation of the products.

In particular, I object to his comments on bi-wiring. If Leo or "we" cannot see the point of bi-wiring I suggest you read "High Performance Loudspeakers", by Martin Colloms (4th edition). He is considered a world authority on loudspeaker design and in his opinion the advantages of bi-wiring are quite clear, whether the crossover be at the amplifier end (preferred) or at the speakers. Briefly, it reduces currents in conductors that are common to HF and LF drivers and reduces the bandwidth each circuit has to handle. Bi-amping is great but bi-wiring has definite advantages, albeit small, but isn't true hifi all about small gains (pun not intended)?

The Jamo Classic 4's appear to use the M-T-M arrangement popular in designs by Joe D'Apolito who writes for "Speaker Builder" magazine and designs systems for major US and Scandinavian manufacturers. I have built his excellent Aria 5's which are similar to the Jamo 4's. I feel Leo missed an opportunity to comment on the properties of this configuration. Where are the frequency, phase and polar response plots, comments on imaging, comparisons with similarly priced units, etc?

An earlier speaker review referred to oxygen-free cable as "a lot of rubbish" or some such comment. Rightly or wrongly, many stereophiles use OFC and I am sure they were insulted by such statements. As you should know, sound reproduction is part science and part art with many grey areas, preferences and opinions and to be dogmatic about any aspect is only to show ignorance of the subject and thereby lose one's credibility.

On a more positive note, I have read SILICON CHIP since its inception and commend you on its quality, broad range of topics and excellent designs, many of which I have built. Electronics and audio have been my profession and hobby since 1948 and I can relate to the "Serviceman" and "Vintage Radio" segments. Please keep up the good work.

R. W. Field,
Bonnie Doon, Vic.

Comment. We note that you have cited Martin Colloms as a "world authority" but the fact is that there is no technical justification for bi-wiring loudspeakers. The Theory of Superposition clearly demonstrates that two signals or voltages do not interact in a passive network but add linearly. Bi-amping is a different matter but to gain the advantages of reduced intermodulation in the amplifiers you need to use an electronic crossover and eliminate the passive network.

We are familiar with the so-called D'Apolito configuration but we are not sure that it was intended as a feature of the Jamo Classic 4's. It would seem logical that if the D'Apolito configuration is to work properly, the tweeter should be at or near ear level. With most small loudspeakers, the D'Apolito arrangement places the tweeter at a lower than optimum level. As far as we know, the central placement of a tweeter flanked by the other drivers above and below was pioneered not by Joe D'Apolito but by Richard Dunleavey with his Duntech speakers, designed and made in Australia.

We do not remember making a comment on oxygen-free copper cables in a previous review but there is no justification for using OFC cables in any audio application. OFC cable was originally developed by Hitachi as a solution to hydrogen embrittlement of conductors inside large alternators in power stations (alternators use a pressurised hydrogen atmosphere). As far as we know, OFC cables were first advocated by Japanese hifi enthusiasts who have a well-known taste for the esoteric. We have not seen one technical paper on the merits of OFC cables for hifi use. **SC**

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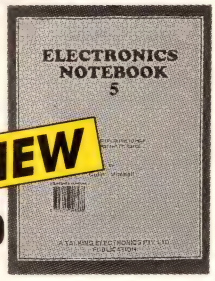

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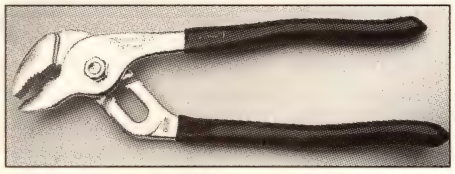

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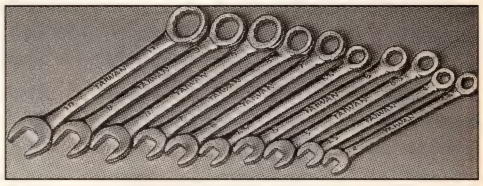

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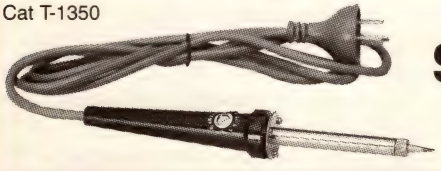

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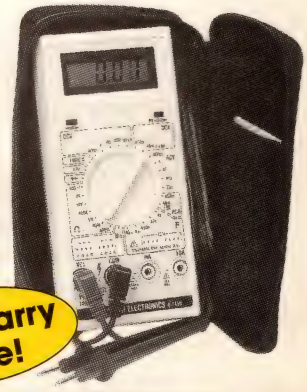

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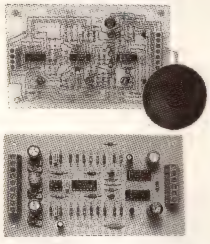

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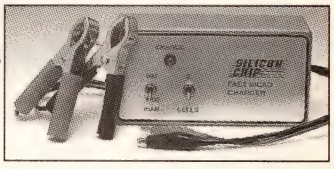

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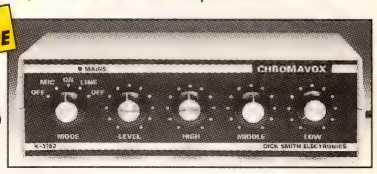

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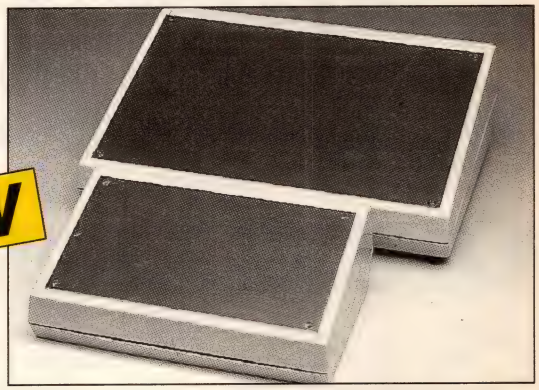

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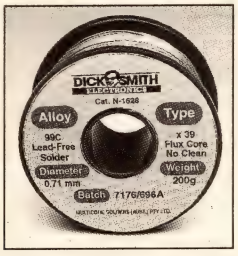

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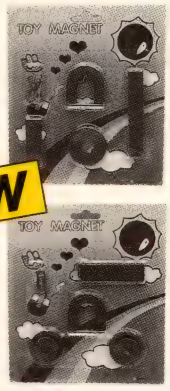

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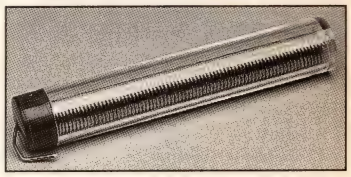

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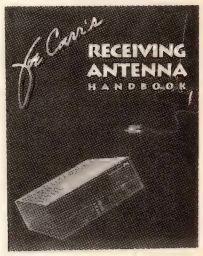

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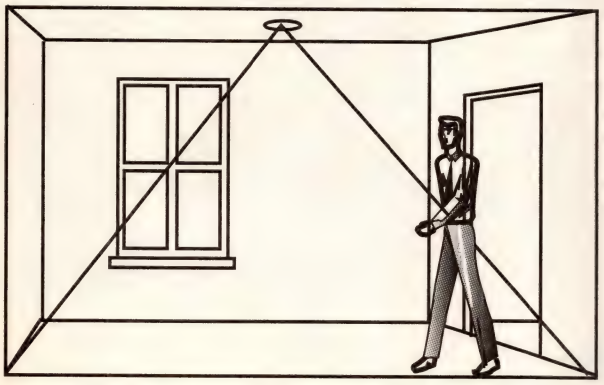

Ceiling PIR Detector

Intruders will have little chance of escaping undetected once you have this installed - it monitors a wide 360° arc! Plus, the very latest technology ensures that it's not triggered unnecessarily by lights located nearby, minimising the chance of false alarm! Easy-to-install, it's designed to be ceiling mounted for convenience and maximum coverage. Suits most alarm systems.

Cat L-5017

$69.95

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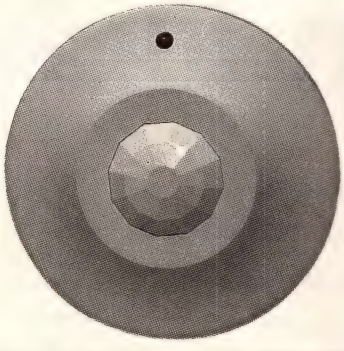
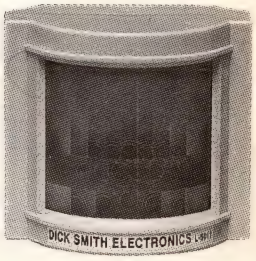


Low-Cost PIR Detector

A great low price for a reliable detector! Compact and unobtrusive, it provides an easily-adjusted range of up to twelve metres through 95°. An indicator LED illuminates when the alarm is triggered and pulse-stretched output minimises false alarms. It can be mounted on any flat surface or corner.

Cat L-5011

$39.95



Compact 180° PIR Detector

Its tiny size means it often goes unnoticed... until triggered! It also means the detector can be wall, ceiling or corner mounted. Highly-sensitive, it offers four interchangeable lenses so you can set it to focus on the area of your choice and has programmable pulse count for greater accuracy and fewer false alarms.

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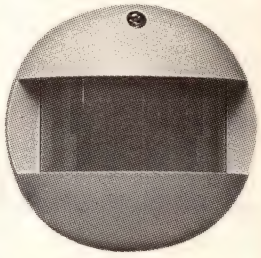

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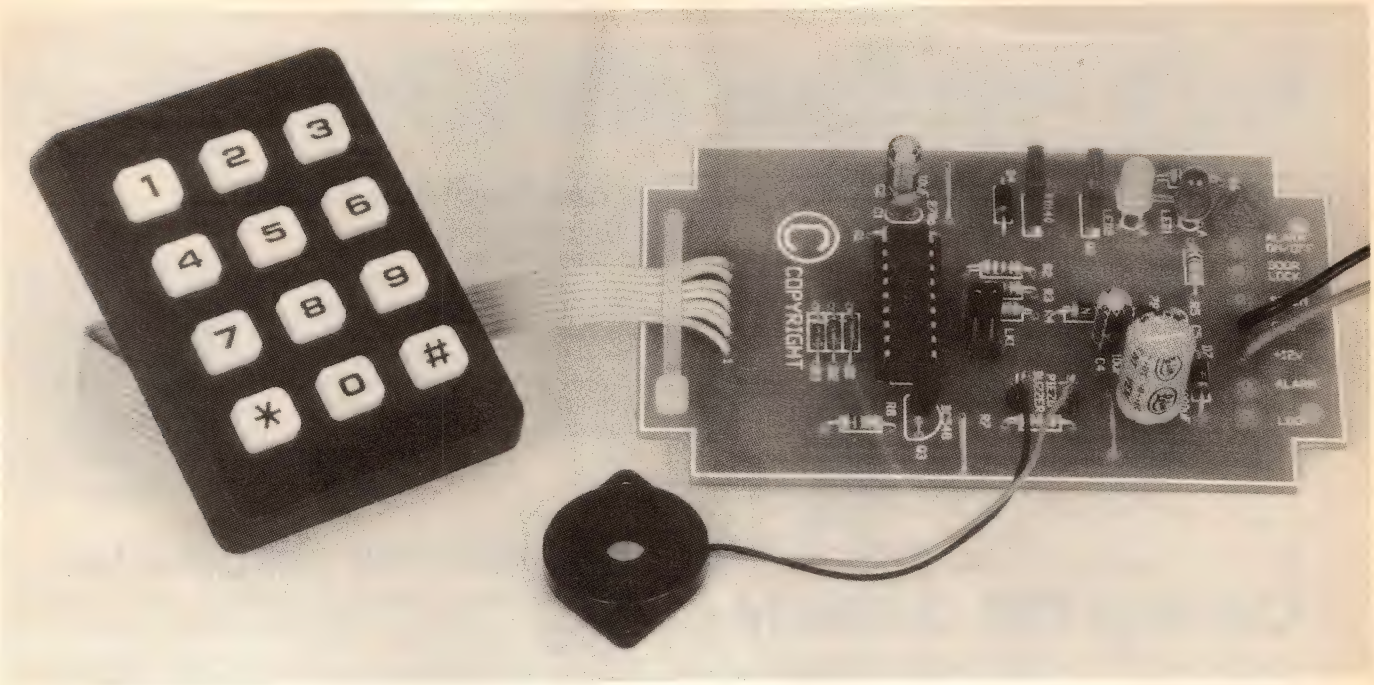


Build a keypad combination lock

This keypad combination lock can be used to arm/disarm a house or car alarm, or to activate a solenoid-operated door strike. It accepts codes up to 12 digits long and is easy to program.

Design by JEFF MONEGAL

Keypad combination locks are a great idea in security applications, since they are far more convenient to use than keys. What's more, the code can be quickly and easily changed at the user's whim to restrict people who previously had access or just to maintain security.

By contrast, keys can be easily copied or lost, while locks are expensive and time-consuming to change.

The Keypad Combination Lock described here can be used in a range of security applications. These include: (1) turning burglar alarms on and off; (2) activating solenoid-operated locking mechanisms in security doors and gates; (3) controlling ignition killers and fuel cutout systems in cars and boats; and (4) operating power doors on garages.

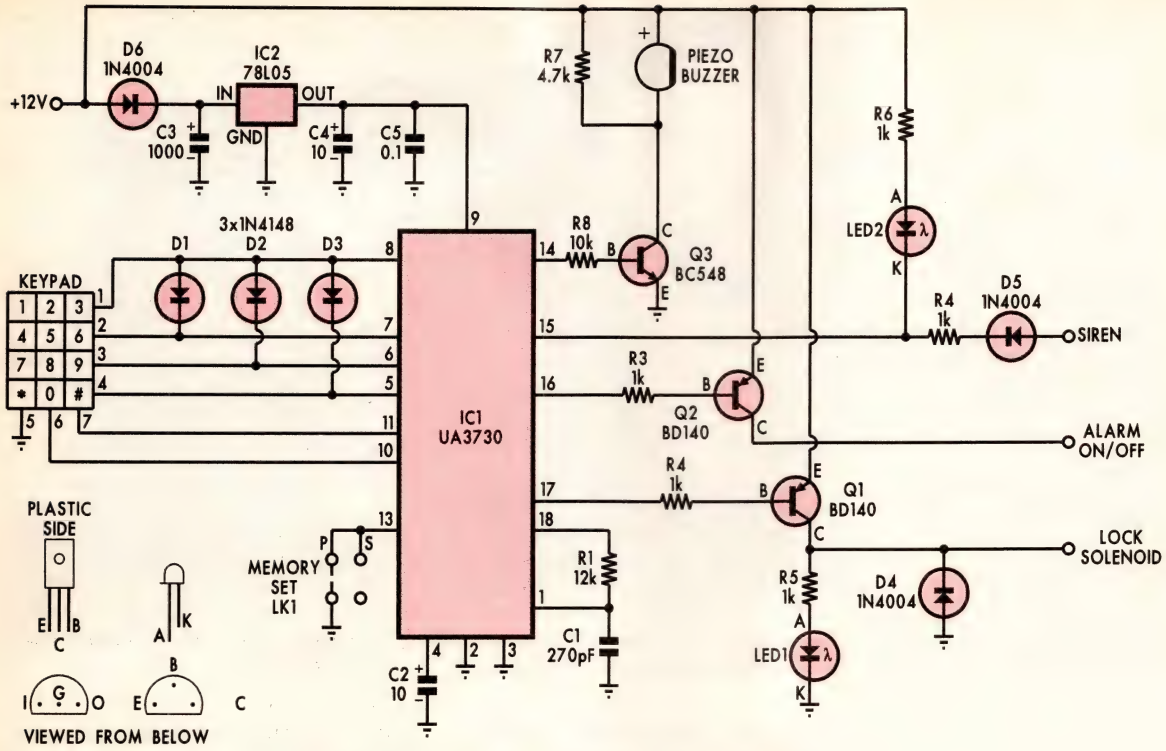
When used with a home burglar alarm, the keypad would typically be mounted just inside the front door. Alternatively, the keypad could be mounted in a weatherproof case just outside the door. That way, you could reduce the entry and exit delays to a bare minimum or simply wire the alarm for instant triggering.

Main features

Unlike previous circuits, this unit is based on a dedicated kepad combination lock IC and this has greatly simplified the circuitry. Called the UA3730, this 18-pin CMOS device contains all the necessary logic circuitry to monitor the keypad matrix, plus the necessary output logic for latched and momentary operation.

In addition, the chip includes onboard memory which is used to store the code. Up to 12 numbers can be stored in memory (for 10^{12} possible combinations) but this will depend on the level of security required. Unlike previous systems, the code can be quickly changed (provided you have access to the PC board), since there are no wire links to solder in or DIP switches to set.

In most cases, a simple 4-digit code will give you adequate security while retaining the benefits of a number that's easy to remember. This number of digits provides odds of greater than 10,000 to one against someone guessing the correct code. Of course, you can use more than four digits for even greater security (although it's never



KEYPAD COMBINATION LOCK

Fig.1: the circuit is based on IC1 which is a UA3730 keypad combination lock IC. This device scans the keypad and, when the correct code is entered, the Alarm On/Off output toggles and the Lock Solenoid output goes high for two seconds. The piezo buzzer echoes the key presses.

a good idea to use your telephone number).

The keypad used is a standard 3 x 4 unit as used in some telephone diallers. It includes the digits 0-9 plus "*" and "#" keys. Only the digits (0-9) can be used as part of the code but you can use the same digit more than once.

Three outputs are provided by the Keypad Combination Lock: (1) Lock Solenoid (momentary); (2) Alarm On/Off (latched); and (3) Siren. The unit is easy to operate – all you have to do is enter the correct code and press the "#" key. A small piezo transducer "beeps" briefly (for 0.2s) each time a key is pressed.

Because it can only register one key at a time, you can't fool the unit by simultaneously pressing all the keys at once. In addition, the IC includes a time-out feature so that you only have one minute to complete the code entry after the first key is pressed. If you take longer than one minute, the IC resets and you have to start all over again.

When the correct code is entered, the Door Lock output goes high for two seconds (to open the door) and lights a red indicator LED. By contrast, the Alarm On/Off output alternately toggles between high (+12V) and open circuit (O/C); ie, it changes state each time the correct code is entered.

The Alarm On/Off output can be used for switching burglar alarms or other equipment on and off, either directly or via a relay.

Wrong code

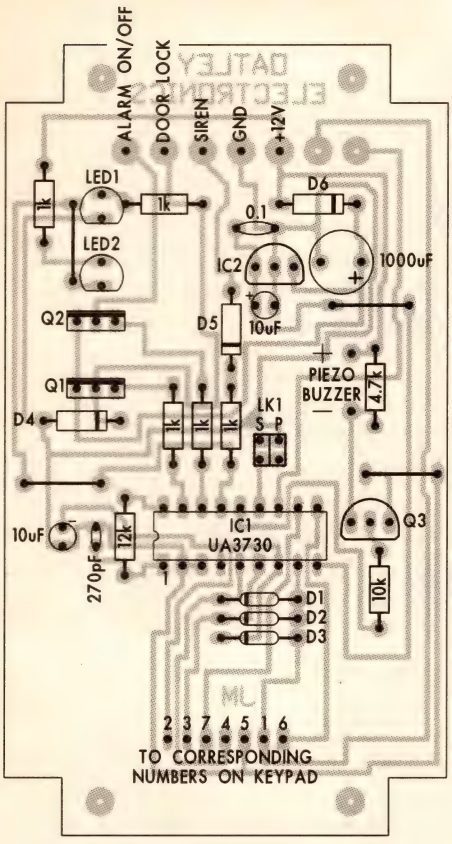
If the wrong code is entered, the transducer beeps once but only on the first two attempts. After the third incorrect attempt, the Siren output goes low for 60 seconds to sound an external siren or trigger a central alarm system. During this period, the transducer beeps once every second and the circuit lights an orange indicator LED.

The circuit subsequently automatically resets at the end of the 1-minute alarm period. Alternatively, the circuit can be reset at any time during the alarm period by entering the correct code.

Note that the use of any output is entirely optional. You might elect to

Features Of The Keypad Combination Lock

- Based on a dedicated combination lock IC.
- Accepts codes up to 12 digits long for 10^{12} possible combinations.
- Code is stored by the IC and is programmed from the keypad.
- Three outputs: (1) Lock Solenoid (momentary); (2) Alarm On/Off (latched); and Siren (1-minute alarm).
- LED indicators for Lock Solenoid and Siren outputs.
- Siren output activated if three incorrect codes entered in sequence.
- Piezo buzzer echoes key presses; beeps once every second for duration of Siren output.
- Programmed code can be maintained in the event of power failure using three dry cells to provide battery backup.



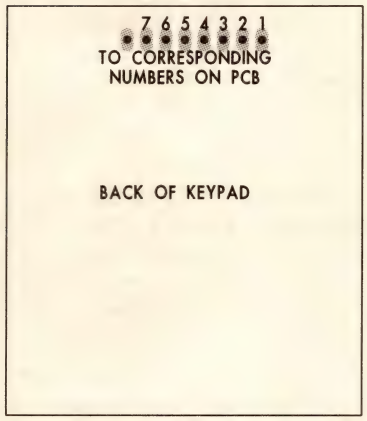
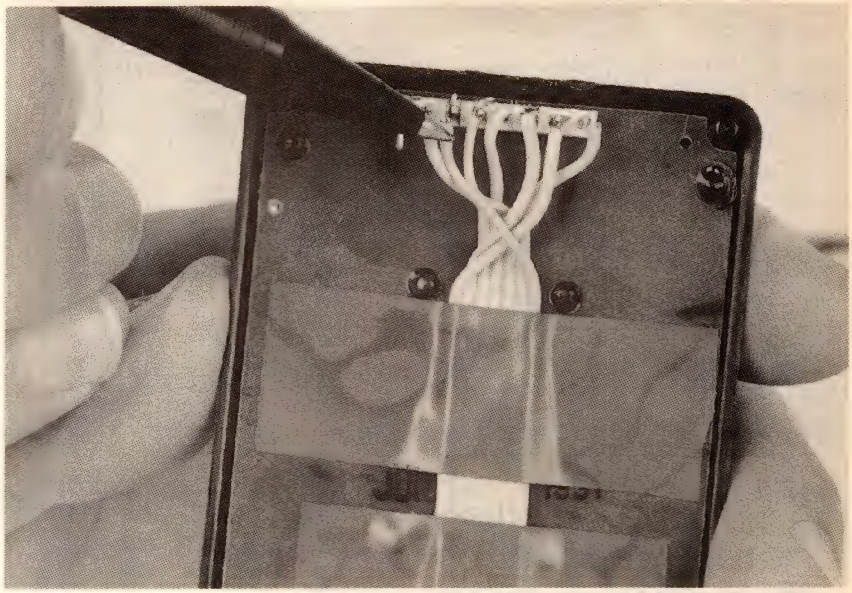


Fig.2: install the parts on the PC board as shown in this layout diagram. The two LEDs can either be mounted on the PC board, or they can be installed along with the keypad on the front panel of a case or switch plate.

use only the Lock Solenoid output, for example, and leave the Alarm On/Off and Siren outputs disconnected.

Supply requirements

Because it is a CMOS device, the UA3730 has a typical quiescent current of just 5µA. This makes it suitable for battery backup using dry cells, since these will last for the length of their shelf-life. In fact, battery backup



Take particular care when wiring the keypad, as some of the leads of the 7-way cable from the PC board have to be crossed over as shown here. Just be sure to connect the wiring exactly as shown in Fig.2.

for the IC is desirable since the memory is volatile. This means that the programmed code is lost if the power is interrupted, with the unit reverting to its default code of 0#.

The circuit itself is powered from a 12V DC source, with the current requirements dictated by the external load. A typical door lock solenoid will require a supply capable of delivering about 400mA but many applications will require only 100mA or less.

Battery backup is not a feature of the original circuit but it can be easily added, as we shall see later on. Note that the suggested circuit using dry cells is only suitable for maintaining the programmed code in the IC until regular power is restored.

Circuit details

Refer now to Fig.1 for the circuit details. Apart from the IC and the keypad, there are just two transistors, a 3-terminal regulator, a piezo transducer and a few minor parts.

R1 and C1 are the timing components for IC1's on-board oscillator. In operation, IC1 scans the keyboard matrix and decodes the key presses. The internal logic of the IC then decides whether or not the correct code has been entered and whether or not it has been entered in the required 1-minute period.

Pins 17, 16 & 15 are the device outputs. Normally, pin 17 of IC1 is high and so PNP transistor Q1 is off. However, each time the correct code is entered, pin 17 goes low for two seconds and so Q1 briefly turns on and supplies current to the door lock solenoid. It also supplies current to LED 1 via a 1kΩ limiting resistor.

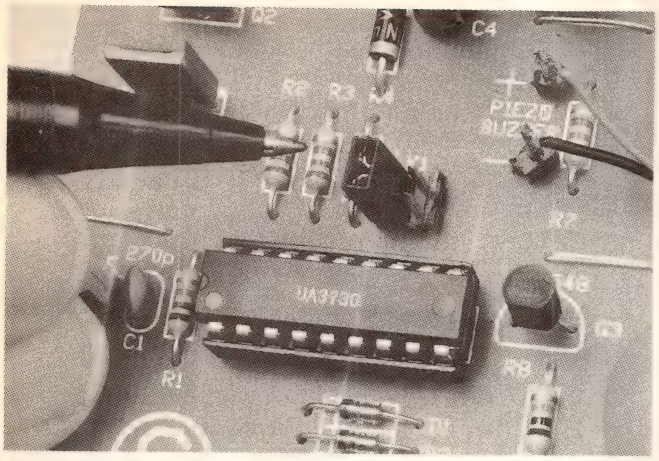
At the same time, pin 16 changes state. If it was high before the code was entered, it switches low and Q2 turns on. Conversely, if it was low, it switches high and Q2 turns off; ie, pin 16 behaves as a latching output.

The third output, pin 15, is normally high but switches low for one minute if three incorrect codes are entered in a row. This lights LED 2 and also drives an external siren circuit via diode D5 and current limiting resistor R4. At the end of the 1-minute period, IC1 resets and pin 15 switches high again.

Pin 14 is the piezo driver output. Each time a key is pressed, this output generates a 3kHz signal for 0.2s which drives Q3. Q3 in turn drives the piezo transducer (B1) with this 3kHz pulse signal. R7 is necessary to provide a DC current path for the transistor.

In addition, pin 14 generates a 0.2s burst at 3kHz each time an incorrect code is entered. It also generates a 3kHz burst every second for a period of one minute if three incorrect codes are entered (ie, while pin 15 is low).

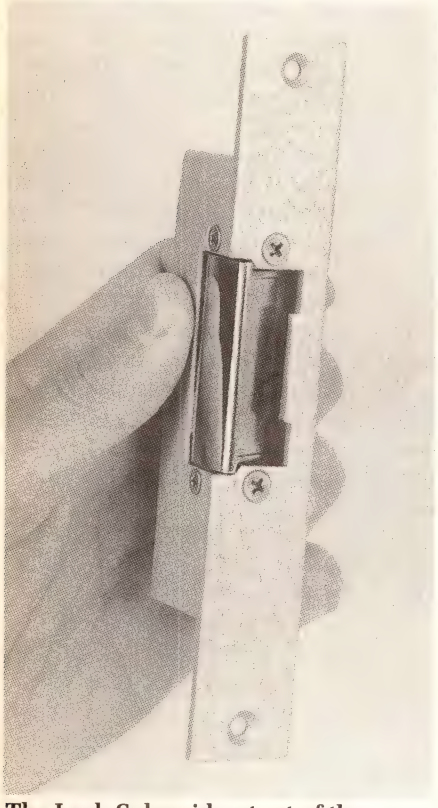
Pin 13 is used to control the pro-



This view shows the programming jumper in the store (S) position. It must be placed in the program (P) position when a new code is to be programmed into the UA3730 IC.

gramming function of IC1. Normally, this pin is left floating but is grounded (by installing link LK1) to program in a new code. The programming link is then removed again after the new code has been entered.

This task has been made easy by installing a pair of adjacent 2-way pin headers on the PC board. A jumper is then used to short out two of the pins in one position to provide the programming link. The other position is simply used to store the jumper when programming has been completed.



The Lock Solenoid output of the circuit can be used to drive a 12V door strike such as the unit shown here (available from locksmiths).

Power for the circuit comes from an external 12V supply (battery or DC plugpack) and is applied to 3-terminal regulator IC2 via reverse polarity protection diode D6. The 5V regulated output from IC2 is then applied to pin 9 of IC1. Capacitors C3, C4 & C5 decouple the input and output terminals of the regulator respectively.

Note that transistors Q1 & Q2 are powered directly from the +12V rail.

Construction

All the parts except the buzzer and the keypad are mounted on a PC board measuring 105 x 60mm. This board carries a screen printed overlay so that you can see at a glance where each part fits. Fig.2 shows the assembly details.

No particular order need be followed when installing the parts on the PC board but take care to ensure that all polarised parts are correctly oriented. In particular, note that the two BD140 transistors are installed with their metal faces towards the LEDs.

There are four wire links on the board. Install these at the locations shown and install the two 2-way pin headers at the LK1 position. Separate pin headers are also installed for the buzzer terminals. Resistors R2 and R3 are shown as 2.2kΩ types on the PC board screened overlay but we recommend that you reduce them to 1kΩ, in line with the circuit diagram.

Depending on the application, the two LEDs can either be installed directly on the PC board, as shown in Fig.2, or connected to the board via flying leads. Make sure that the LEDs are correctly oriented – the anode lead is usually (but not always) the longer of the two. It is a good idea to check this point with your multimeter before the LEDs are installed. The red LED is used for LED 1 (alarm on/off), while the orange LED is used for LED 2 (ie, siren indication).

The IC is best left until last. It is installed in an IC socket and must be oriented so that its pin 1 is adjacent to R1 (12kΩ).

PARTS LIST

1 PC board, 105 x 60mm, copyright Oatley Electronics
1 keypad
1 12V piezo transducer
1 plastic cable tie
1 200mm-length 7-way ribbon cable
1 18-pin IC socket
3 2-way pin headers
1 jumper (for pin headers)
1 80mm-length of tinned copper wire (for links)

Semiconductors

1 UA3730 CMOS electronic lock (IC1)
1 78L05 3-terminal regulator (IC2)
2 BD140 PNP transistors (Q1,Q2)
1 BC548 NPN transistor (Q3)
1 5mm red LED (LED1)
1 5mm orange (LED2)
3 1N4148 signal diodes (D1-D3)
3 1N4004 silicon diodes (D4-D6)

Capacitors

1 1000µF 16VW electrolytic
2 10µF 16VW electrolytic
1 0.1µF monolithic
1 270pF ceramic

Resistors

1 12kΩ
1 10kΩ
1 4.7kΩ
5 1kΩ

WHERE TO BUY A KIT

A kit of parts comprising the PC board, all on-board parts, the keypad and the piezo transducer is available from Oatley Electronics for $20 plus $4 p&p. A suitable plastic case (see photo) costs an extra $4. Contact Oatley Electronics, PO Box 89, Oatley, NSW 2223. Phone (02) 579 4985 or fax (02) 570 7910.

Note: copyright the PC board associated with this design is retained by Oatley Electronics

Adding Battery Backup & Alarm On/Off Indication

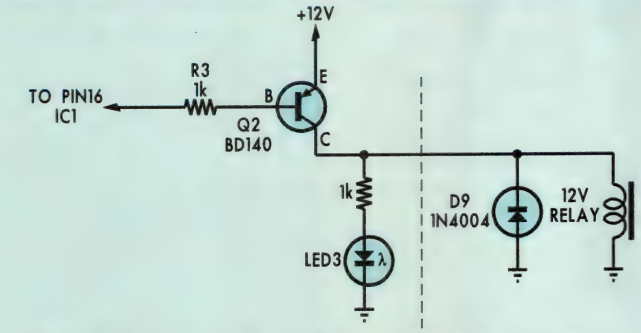


Fig.3: this diagram shows how to add LED indication and a relay to the Alarm On/Off output. If you don't need the relay, just leave it (and D9) out.

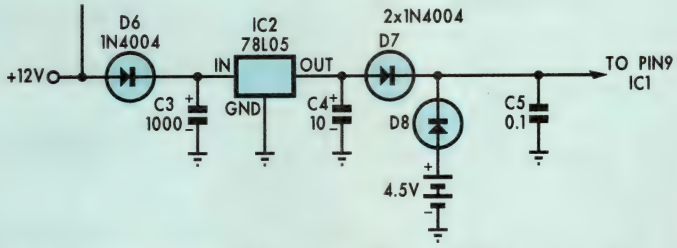


Fig.4: here's how to add battery backup to the circuit. Note that this circuit is only intended to maintain the code in the UA3730 IC in the event of a power failure.

Once the board assembly is completed, it can be wired to the keypad via a 7-way ribbon cable. A cable length of 150mm should be sufficient for most applications. You will need to take extreme care when making the connections to the keypad, since some of the leads must be crossed over to reach their correct terminals. Just ignore the screened "1" on the PC board and connect the leads as shown in Fig.3.

A plastic cable tie is used to anchor the keypad cable to the PC board, to stop the leads from coming adrift.

Finally, the piezo transducer can be wired into circuit. Be sure to connect the red lead to the positive terminal. The Keypad Combination Lock is now ready for testing.

Testing

All you have to do here is connect a 12V DC power supply to the unit and try it out.

Wait a few seconds after switch on for the circuit to reset correctly – the piezo transducer will beep when all is ready. Now press 0# and check that LED 1 lights for two seconds and then goes out again. If it does, then all is well and you can check the other two outputs.

To do this, use a multimeter (set to a low DC range) to monitor the Alarm On/Off output and check that this output toggles each time the correct code is entered. This done, check that the transducer beeps once every second and that LED 2 lights for a period of one minute when three incorrect codes are entered.

Changing The Code

The default code for the unit is "0" and this is entered by pressing "0" on the keypad and then pressing the "#" key. To change the code:

(1) Place the jumper in the "P" (program) position of LK1.

(2) Enter the desired code (up to 12 digits).

(3) Press the "*" key.

(4) Transfer the jumper to the "S" (store) position of LK1 (this is necessary, otherwise the unit can be quickly reprogrammed from the keypad).

If you strike problems, first check that the keypad is wired correctly, as it's easy to make a mistake here. This done, check that all polarised parts are correctly oriented and that the correct part has been used at each location.

Programming

To program the unit, first install the jumper between the two pin header terminals labelled "P" at the LK1 position (ie, between the two righthand terminals) – see Fig.2. Pin 13 of IC1 is now grounded. Now enter in the required code (up to 12 digits), press the "*" key and transfer the jumper to the store (S) position.

Your new code is now programmed into the lock. Check that the unit will recognise this code by keying it in and pressing the "#" key.

Options

(1) Alarm On/Off Indicator: Most burglar alarms sound a small buzzer during the exit and entry periods, so a LED indicator was considered unnecessary for the Alarm On/Off output. If you do need a LED indicator on this output, then it can be easily added as shown in Fig.3.

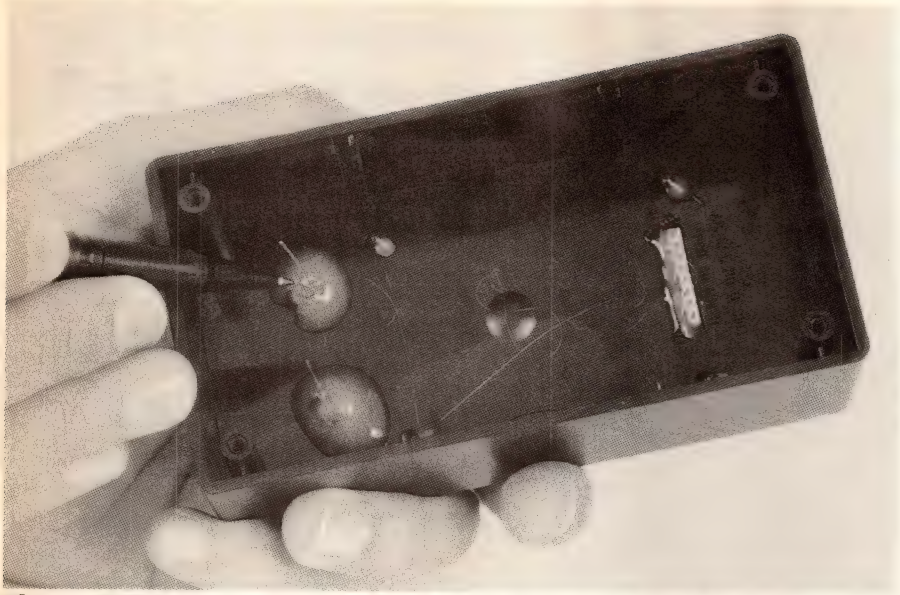
Fig.3 also shows how this output could be used to drive a relay. Note that a diode must be connected across the relay coil to protect Q2 from voltage spikes when the relay turns off.

(2) Battery Backup: A 4.5V battery pack (eg, three 1.5V dry cells) and a couple of 1N4004 diodes are all that are required to maintain the code programmed into IC1 if the power fails. Fig.4 shows how this is done.

The circuit works like this: normally, the cathode of D7 is at 4.5V and so D8 will be reverse biased and no current flows from the batteries. However, if the power fails, D8 becomes forward biased and the backup batteries take over and supply IC1.

D7 can be easily added to the existing PC board by substituting it for the wire link immediately below the 1000µF capacitor (C3). Be sure to install it with its cathode lead to the right. D8 can be wired in series with the positive supply lead from the batteries and its cathode connected to D7's cathode.

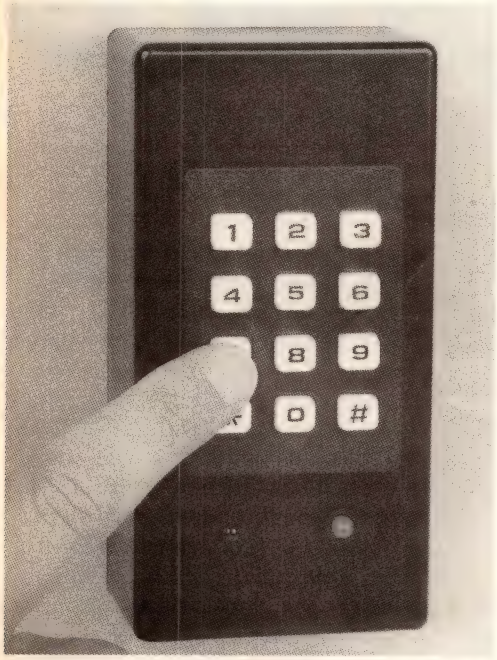
(3) Door Sensor: Although not shown on the circuit of Fig.1, pin 12 is designated as the on/off sensor input. This pin is normally left floating



The two LED indicators can be affixed to the plastic case using epoxy resin, as shown here. Similarly, the keypad is attached by first drilling clearance holes for its four corner posts and then using epoxy resin to glue these corner posts to the inside of the case.

but if it is shorted to the commoned anodes of D1-D3, the siren output goes low for one minute (ie, the effect is the same as if three incorrect codes are entered in sequence).

Despite not being shown on the circuit, provision for this feature has been made on the PC board. All you have to do is wire the two unused pads to a normally open switch (eg, a reed switch or an under-carpet pressure mat), or even several switches wired in parallel. These switches could be used to detect other doors or windows being forced.



Mounting the circuit in a plastic case is OK for low-security applications. Alternatively, you can mount the keypad on a blank mains wall plate and hide the PC board close by in the wall cavity.

Installation

The exact method of installation will depend on the application but make sure that the electronic circuitry is secure so that the keypad cannot be circumvented.

In most cases, the keypad can be mounted on a blank mains wall plate and this can be installed with the PC board behind it in a wall cavity. This means that the two indicator LEDs would also have to be mounted on the wall plate (eg, directly beneath the keypad) and connected to the PC board via flying leads. The LEDs can be secured using epoxy resin.

Another option is to mount the keypad and circuitry in a plastic utility case and this method would be suitable for low-security applications.

Power for the circuit can be derived either from a DC plugpack supply or from an existing alarm power supply, preferably with battery backup. Note that if the alarm system has a battery backup, then the optional battery backup circuit depicted in Fig.3 is unnecessary. **SC**

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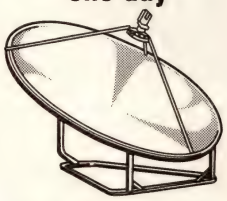

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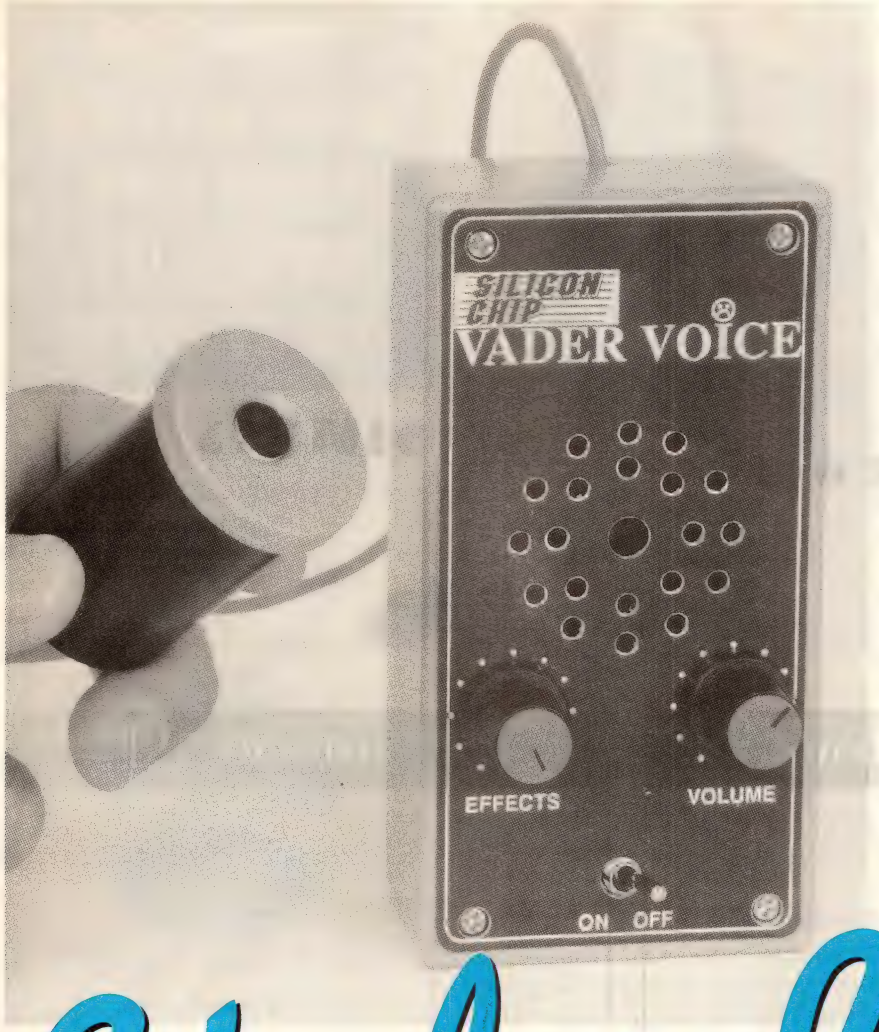


Disguise your voice to sound like Darth Vader from "Star Wars" or a Cylon from "Star Trek". With the added menace of a new strange-sounding voice, you too can travel the galaxy for profit and entertainment.

By JOHN CLARKE

Vader Voice

THE DARTH VADER and Cylon characters have always had great appeal, probably because of their distinctive metallic voice styles. This simple project lets you imitate the dastardly Darth and other diabolical characters from the nether regions of the galaxy. All you do is switch it on, speak into a small electret microphone and adjust a single pot to get the effect you want.

Now it's quite possible that some people might not see the need for building such a handy space-war accessory as this. To others, the reasons will be self-evident – after all, why should you be forced to stick with your own everyday boring voice?

As can be seen from the photos, the Vader Voice is housed in a small plastic case. The controls include an effects rate adjustment (which varies the type of sound), a volume control to set the output level from the loudspeaker and an on/off switch. The loudspeaker is mounted inside the case while the microphone is located in a small film canister connected via a length of shielded cable.

How it works

Fig.1 shows the block diagram for the Vader Voice. The action starts on the lefthand side, where an electret microphone feeds signal to an op amp stage (IC1a) which has a gain of about 15. A chopper circuit (ie, CMOS switch IC2) then switches the signal on and off at a rate determined by oscillator stage IC3 and potentiometer VR1.

The output from the chopper stage is fed to a 3kHz low-pass filter based on IC1b. This stage removes the residual signals produced by the switching action in IC2. Finally, IC4 feeds the processed signal to power amplifier stage IC4 via volume control VR2.

Fig.2 illustrates how the circuit produces the sound effects. Waveform A is the audio signal from the microphone after passing through amplifier IC1a, while waveform B is the square wave output from the oscillator. Waveform C shows the audio signal after it has been "chopped" at the oscillator frequency.

The bottom waveform at D shows

the corresponding output from the low-pass filter (IC1b). Note that this waveform is quite different in appearance to the original waveform shown at A and it sounds correspondingly different too.

Refer now to Fig.3 for the complete circuit. Apart from the microphone and loudspeaker, it uses four low-cost ICs plus a few resistors and capacitors.

The electret microphone requires a bias in order to function. This is supplied via a 10kΩ resistor which is decoupled from the supply rail via a 1kΩ resistor and 33µF capacitor. This decoupling arrangement is necessary to prevent supply line fluctuations caused by the power amplifier stage from modulating the microphone and causing positive feedback.

The signal from the electret microphone is fed via a .0033µF capacitor to pin 3 of op amp IC1a. This stage is connected as a non-inverting amplifier with a gain of about 15, as set by the 470kΩ feedback resistor and the 33kΩ resistor on pin 2 (ie, Gain = 1 + 470/33 = 15.2).

IC1a is biased at half the supply voltage via two 220kΩ resistors and the associated 470kΩ resistor connected to pin 10. A 10µF electrolytic capacitor decouples the half-supply voltage, which is also used to bias pins 2 & 1 of IC2 and pin 5 of op amp IC1b. As a result of this bias arrangement, the output from IC1a swings above and below +4.5V.

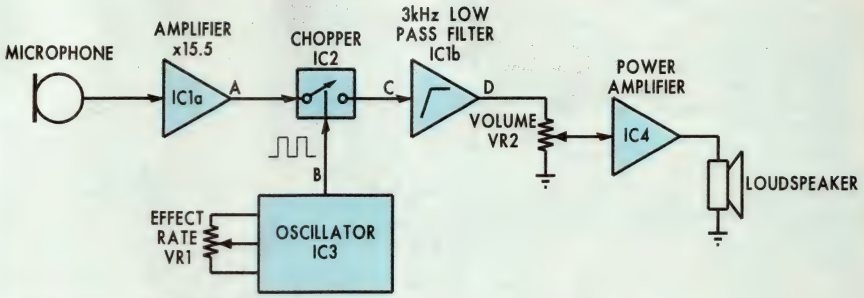


Fig.1 (above): block diagram of the Vader Voice. The signal from the microphone is amplified in IC1a and "chopped" in IC2 at a rate set by oscillator IC3. The resulting signal is ten filtered in IC1b and fed to audio amplifier stage IC4.

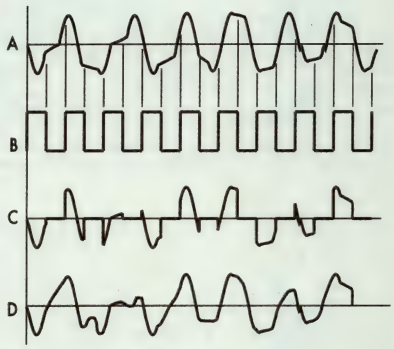
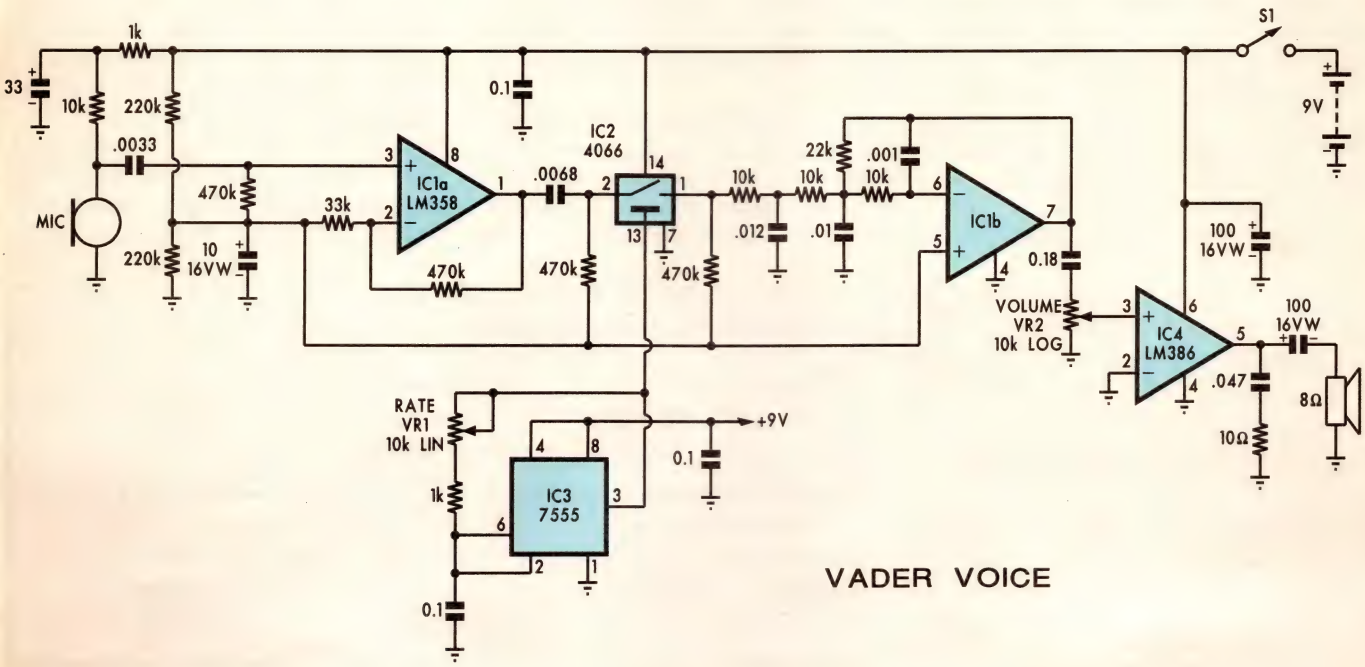


Fig.2 (right): this diagram shows the effect on the input waveform at various points in the circuit. Note that the output waveform (D) is quite different to the input waveform (A).

The oscillator stage is formed by IC3 which is a 7555 CMOS timer. This stage generates a square wave output with a frequency in the range from 1.3kHz to 14kHz, depending on the setting of VR1. Let's see how it works.

At switch on, the 0.1µF timing capacitor is initially discharged and the output at pin 3 is high. The 0.1µF capacitor then charges via the 1kΩ resistor and VR1 until it reaches $^2/_3$Vcc (ie, $^2/_3$ the supply voltage). When it does, pin 3 switches low and the timing capacitor discharges via the 1kΩ resistor and VR1 until it reaches $^1/_3$Vcc. This switches pin 3 high again and so the process is repeated indefinitely while ever power is applied.

Fig.3 (below): the final circuit uses 7555 timer IC3 to drive CMOS switch IC2 and this stage in turn chops the audio waveform from IC1a. IC1b is the 3kHz low-pass filter stage and this drives IC4 via volume control VR2.



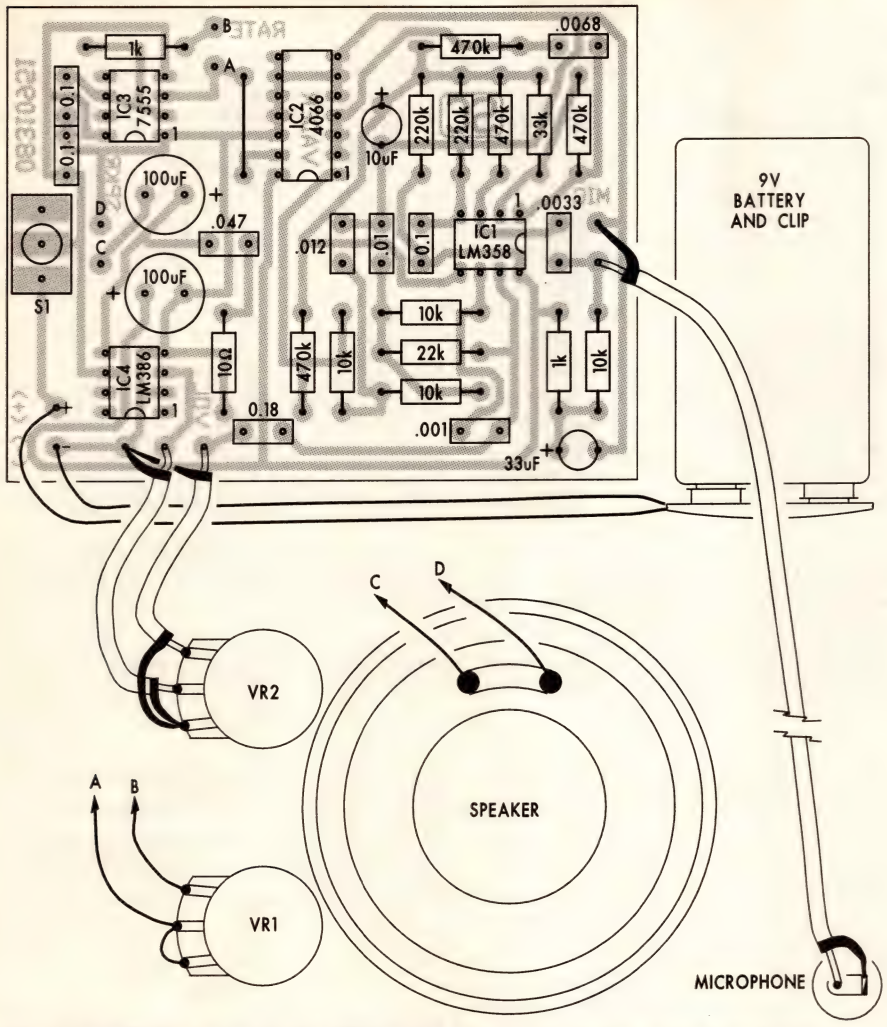


Fig.4: install the parts on the PC board and complete the wiring as shown in this diagram. Note that shielded cable is used for the connections to volume control VR2 and to the electret microphone.

The square wave output at pin 3 of IC3 toggles CMOS analog switch IC2 on and off. When pin 3 of IC3 is high, the CMOS switch is closed. Conversely, when pin 3 is low, the CMOS switch is open. As a result, the signal from IC1a is gated at the oscillator frequency before it is fed to IC1b.

IC1b and its associated resistors and capacitors form the third order low-pass filter. This rolls off the signal above 3kHz at 60dB per decade (ie, 20dB/octave). This means that at 30kHz the signal is attenuated by 60dB.

The filtered signal appears at pin 7 of IC1b and is AC-coupled via a 0.18µF capacitor to volume control VR2. This AC coupling prevents DC from flowing in VR2, which would cause noise in the output each time the potentiometer was operated.

Following VR2, the signal is coupled to pin 3 of IC4, an LM386 audio amplifier which is capable of driving an 8Ω loudspeaker at an output power of up to 1W. Its output appears at pin 5 and drives the loudspeaker via a 100µF capacitor which rolls off the response below about 200Hz. In addition, a Zobel network consisting of a .047µF capacitor and a 10Ω resistor is connected across the output of IC4 to prevent high frequency instability.

Power for the circuit comes from a 9V battery and is applied via on/off switch S1. A 100µF electrolytic capacitor provides supply line decoupling, to minimise variations due to the peak currents through the LM386 audio amplifier.

Construction

A PC board coded 08310951 carries most of the parts for the prototype. This board was housed in a plastic case measuring 130 x 67 x 43mm, while a self-adhesive label was designed for the front panel.

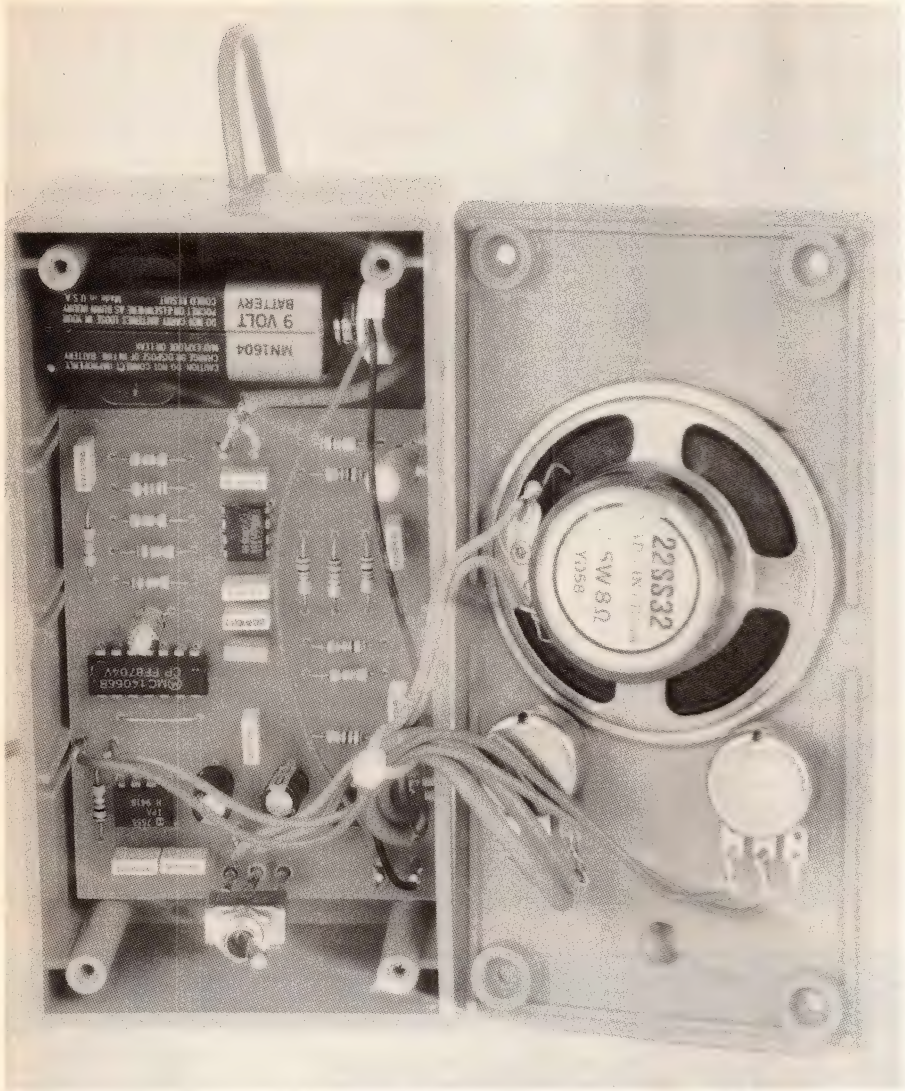
Fig.4 shows the wiring details. Start the PC board assembly by installing PC stakes at all external wiring points and at the S1 position. This done,

TABLE 2: CAPACITOR CODES

Value	IEC Code	EIA Code
0.18µF	180n	184
0.1µF	100n	104
.047µF	47n	473
.012µF	12n	123
.01µF	10n	103
.0068µF	6n8	682
.0033µF	3n3	332
.001µF	1n0	102

TABLE 1: RESISTOR COLOUR CODES

No.	Value	4-Band Code (1%)	5-Band Code (1%)
4	470kΩ	yellow violet yellow brown	yellow violet black orange brown
2	220kΩ	red red yellow brown	red red black orange brown
1	33kΩ	orange orange orange brown	orange orange black red brown
1	22kΩ	red red orange brown	red red black red brown
4	10kΩ	brown black orange brown	brown black black red brown
2	1kΩ	brown black red brown	brown black black brown brown
1	10Ω	brown black black brown	brown black black gold brown



The PC board was secured by clipping it into slots that run along either side of the case, while the loudspeaker was fastened to the lid using contact adhesive. Make sure that the battery clip is correctly wired to the board.

PARTS LIST

1 PC board, code 08310951, 82 x 62mm
1 plastic case, 130 x 67 x 43mm
1 front panel label, 62 x 212mm
2 knobs
1 SPDT toggle switch (S1)
1 57mm diameter 8-ohm loudspeaker
1 9V battery clip
1 9V battery
12 PC stakes
1 electret microphone insert
1 16mm 10kΩ linear pot (VR1)
1 16mm 10kΩ log pot (VR2)
1 800mm-length of shielded cable
1 80mm-length of twin speaker wire
1 200mm-length of hookup wire
1 20mm-length of 0.8mm tinned copper wire

Semiconductors

1 LM358N dual op amp (IC1)
1 4066B quad analog switch (IC2)
1 7555 CMOS timer (IC3)
1 LM386N audio amplifier (IC4)

Capacitors

2 100µF 16VW PC electrolytic
1 33µF 16VW PC electrolytic
1 10µF 16VW PC electrolytic
1 0.18µF MKT polyester
3 0.1µF MKT polyester
1 .047µF MKT polyester
1 .012µF MKT polyester
1 .01µF MKT polyester
1 .0068µF MKT polyester
1 .0033µF MKT polyester
1 .001µF MKT polyester

Resistors (0.25W, 1%)

4 470kΩ	4 10kΩ
2 220kΩ	2 1kΩ
1 33kΩ	1 10Ω
1 22kΩ	

Miscellaneous

Plastic 35mm film canister, epoxy resin, solder

install the wire link adjacent to IC2, then install the resistors and capacitors. Tables 1 & 2 show the resistor and capacitors codes but it is also a good idea to check the resistor values using a multimeter, as some colours can be difficult to read.

Take care to ensure that the four electrolytic capacitors are correctly oriented. In particular, note that the two 100µF capacitors are oriented in opposite directions.

The three ICs can now be installed, again taking care to ensure that they are all correctly oriented. It is quite easy to identify pin 1 of an IC, as it is always adjacent to a dot or notch in one end of the IC's body (see Fig.4). Be careful not to get the 8-pin ICs mixed up and don't use a conventional 555 timer for IC3. It must be a CMOS 7555 type to ensure low battery drain.

Switch S1 is mounted on top of the PC stakes, to give it sufficient height to later protrude through the front panel. When the PC board has been completed, it can be clipped into the case as shown in the photo.

Next, affix the adhesive label to the lid of the case and use it as a template for drilling the holes. You will have to drill holes for the Volume and Effect pots, the Power switch and the loudspeaker grille. A small hole is also required in one end of the case for the microphone lead.

Take care when mounting the two pots on the lid. VR1 (Effects) is a 10kΩ linear type, while VR2 (Volume) is a 10kΩ log type. The loudspeaker is mounted using contact adhesive.

Once everything is in position, the wiring can be completed as shown in Fig.4. Light-duty figure-8 cable is used for the loudspeaker connections and for wiring the Effects pot, while shielded cable must be used for the Volume control wiring. The battery clip can also be wired in at this stage – be sure to connect the red lead to the positive terminal on the PC board.

Shielded cable must also be used

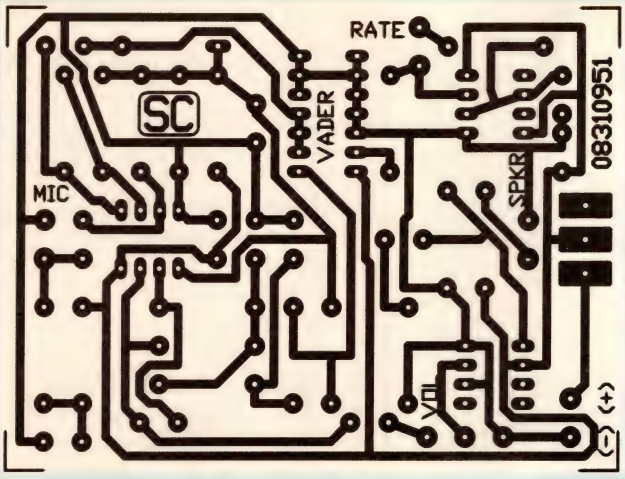


Fig.5: this is the full-size etching pattern for the PC board. Check your board carefully before installing any parts.

for the microphone lead. Use a length of about 600mm and feed it through the end of the case before soldering it to the PC board terminals. The microphone itself can be mounted in a plastic film canister or some other similar plastic container.

In the prototype, the microphone was mounted through a hole drilled in the cap of the film canister and secured with a dab of epoxy. The lead passes through a second hole drilled in the bottom of the canister.

Finally, the battery can be clipped into position and the lid attached.

Testing

To test the project, simply switch it on, wind the volume control up and speak into the microphone. You should immediately be rewarded with a metallic sounding voice. Adjust the Effects pot (VR1) until you obtain the sound you want. All you need now is a helmet, a black cloak, a breathing mask and a light stick to terrorise the galaxy, or just the immediate neighbourhood.

If Darth doesn't do his stuff, first check that each component is in its correct location and that all polarised parts are correctly oriented. You should also carefully check the underside of the PC board for solder bridges or missed (or bad) solder connections.

Next, check for +9V on pin 8 of IC1, pin 14 of IC2, pins 4 & 8 of IC3 and pin 6 of IC4. Pins 2 & 5 of IC1 should be at +4.5V, as should pins 1 & 2 of IC2. Check the relevant circuit components carefully if you do encounter any incorrect voltages.

If all you get is your normal amplified voice, check that oscillator IC3 is working correctly. It should have an average voltage of 4.5V at pin 3, as measured on a multimeter. If you don't get any sound at all, try bridging pins 2 & 1 on IC2. This will tell you whether or not CMOS switch IC2 is functioning, or whether the fault lies elsewhere in the circuit. **SC**

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Common-Mode Rejection Ratio: 25:1 to 10MHz; 10:1 from 10-50MHz, 6cm sinewave. (ADD Mode with Ch 2 inverted.)
Display Modes: Ch 1, Ch 2 (normal or inverted), alternate, chopped (250kHz rate), added, X-Y.
Input R and C: 1MΩ ±2%; approx 20pF.
Max Input Voltage: DC or AC coupled ±250VDC + peak AC at 50kHz, derated above 50KHz.

HORIZONTAL DEFLECTION
Timebase A: 0.5s/div to 0.05µs/div in 22 steps (1-2-5 sequence). X10 mag extends fastest sweep rate to 5ns/div. **Timebase B**: 50ms/div to 0.05µs/div in 19 steps (1-2-5 sequence). X10 mag extends maximum sweep rate to 5ns/div. **Horizontal Display Modes**: A, A Intensified by B, B delayed by A, and mixed.

CALIBRATED SWEEP DELAY
Calibrated Delay Time: Continuous from 0.1µs to at least 5s after the start of the delaying A sweep.
Differential Time Measurement Accuracy: for measurements of two or more major dial divisions: +15°C to +35°C 1% + 0.1% of full scale; 0°C to +55°C additional 1% allowed.

TRIGGERING A & B
A Trigger Modes: Normal Sweep is triggered by an internal vertical amplifier signal, external signal, or internal power line signal. A bright baseline is provided only in presence of trigger signal. Automatic: a bright baseline is displayed in the absence of input signals. Triggering is the same as normal-mode above 40Hz. Single (main time base only). The sweep occurs once with the same triggering as normal. The capability to re-arm the sweep and illuminate the reset lamp is provided. The sweep activates when the next trigger is applied for rearming. **A Trigger Holdoff**: Increases A sweep holdoff time to at least 10X the TIME/DIV settings, except at 0.2s and 0.5s.
Trigger View: View external and internal trigger signals; Ext X1, 100mV/div, Ext -: 10, 1V/div.
Level and Slope: Internal, permits triggering at any point on the positive or negative slopes of the displayed waveform. External, permits continuously variable triggering on any level between +1.0V and -1.0V on either slope of the trigger signal.
A Sources: Ch 1, Ch 2, NORM (all display modes triggered by the combined waveforms from Ch 1 and 2), LINE, EXT, EXT :-10. **B Sources**: B starts after delay time; Ch 1, Ch 2, NORM, EXT, EXT :-10.

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Sensitivity: 5mV/div to 5V/div in 10 steps (1-2-5 sequence) through the vertical system. Continuously variable between steps and to at least 12.5V/div.
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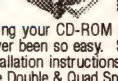

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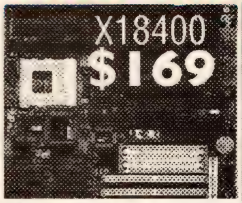

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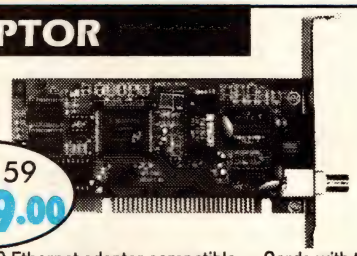

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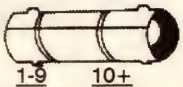

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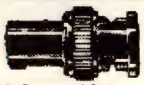

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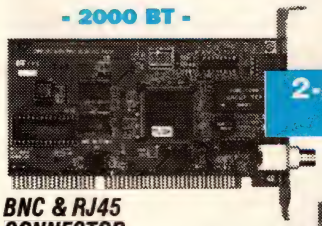
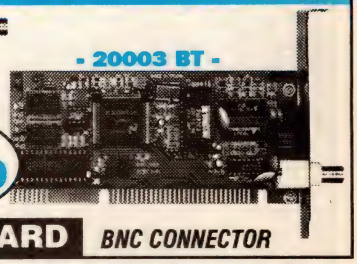


X18165
$79.00

2-in-1 (BNC and RJ45) ETHERNET CARD

BNC & RJ45 CONNECTOR

- 20003 BT -



X18161
$69.00

BNC ETHERNET CARD

BNC CONNECTOR

BNC TERMINAL 93 OHM ARCHET

	1-9	10+
P10528	$3.50	$2.50

BNC PLUG TO UHF PLUG

	1-9	10+
P10529	$6.95	$4.95

BNC CRIMP PLUG

	1-9	10+
P10530	$3.25	$2.95

BNC SOLDERLESS TWIST ON PLUG

	1-9	10+
P10531	$3.95	$3.75

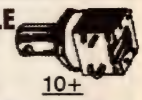
BNC FEMALE LINE JACK SUIT RG59

	1-9	10+
P10535	$2.95	$2.50

BNC PCB MOUNTING

	1-9	10+
P10544	$4.95	$3.95

BNC RIGHT ANGLE PCB MOUNTING



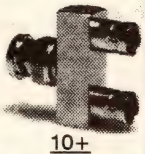
	1-9	10+
P10545	$4.95	$3.95

BNC SOCKETS

"F" SHAPE ADAPTOR PLUG TO TWO SOCKETS

	1-9	10+
P10604	$9.95	$8.95

"Y" SHAPE ADAPTOR PLUG TO TWO SOCKETS



	1-9	10+
P10606	$9.95	$8.95

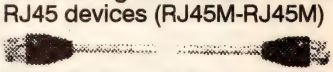
ETHERNET CABLES

Solve your networking problems with our varied length ethernet cables. Save heaps!

- **BNC 50 OHM 2M NETWORKING CABLE M-M** P37702 ..... **$7.95**
- **BNC 50 OHM 3M NETWORKING CABLE M-M** P37703 ..... **$9.50**
- **BNC 50 OHM 5M NETWORKING CABLE M-M** P37705 ..... **$10.95**
- **BNC 50 OHM 10M NETWORKING CABLE M-M** P37710 ..... **$16.95**
- **BNC 50 OHM 15M NETWORKING CABLE M-M** P37715 ..... **$22.95**
- **BNC 50 OHM 20M NETWORKING CABLE M-M** P37720 ..... **$29.95**
- **BNC 50 OHM 30M NETWORKING CABLE M-M** P37730 ..... **$39.95**
- **BNC 50 OHM 40M NETWORKING CABLE M-M** P37740 ..... **$49.95**

UTP (LEVEL 5) PATCH CABLE

Connecting to 10 BASE "T" and RJ45 devices (RJ45M-RJ45M)



- **RJ45M - RJ45M 0.5M Patch Cable** P37760 ..... **$8.95**
- **RJ45M - RJ45M 1M Patch Cable** P37762 ..... **$9.95**
- **RJ45M - RJ45M 2M Patch Cable** P37764 ..... **$10.95**
- **RJ45M - RJ45M 3M Patch Cable** P37766 ..... **$11.95**
- **RJ45M - RJ45M 5M Patch Cable** P37768 ..... **$16.95**

SCMT-HB2-AUG'95S

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ROD IRVING ELECTRONICS PTY. LTD.
YOUR FIRST CHOICE IN QUALITY ELECTRONICS A.C.N. 005 428 437 ESTABLISHED SINCE 1977

NEW KITS NEW KITS NEW KITS NEW KITS

LED BATTERY VOLTAGE INDICATOR

Here's a flexible circuit that can be used in just about any piece of battery operated equipment, to combine the functions of a power-on LED and battery voltage indicator. Measuring only 25mm square, the circuit can be easily mounted in the smallest of spaces, to give you warning of impending battery failure.

EA ***SEPT'95***

NEW

K10690 **$12.45**

JACOB'S LADDER DISPLAY

NEW

Ever since scientific showmen like Tesla and Edison were able to generate really high voltages, the Jacob's Ladder display has been creating awe amongst laymen.

NO PICTURES AVAILABLE AT TIME OF PUBLICATION

Without COIL
K10695 ***$29.95***

With COIL
K10696 ***$59.95***

IMPROVED FLEXITIMER MK2

This simple but extremely flexible circuit can be used for just about any semi-fixed timing applications, with its ability to select timing periods from seconds to days. It has four separate outputs, two independant and programmable timing "events", can be sychronised awith the 50Hz mains or driven by an internal RC clock, and can be powered from either an AC or DC source.

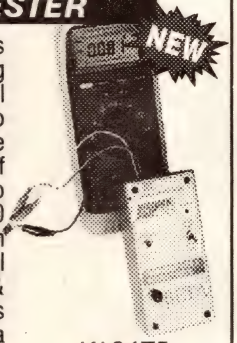
EA ***AUG'95***

K10685 **$22.95**

LOW COST TRANSISTER & MOSFET TESTER

This handy tester is designed to plug into a digital multimeter to provide accurate measurement of transistor beta, to values up to 50,000 or more. You can use it to test small signal, power & Darlingtons transistors &, as a bonus, it will check Mosfets.

SC ***May '95***



NEW

K10675 **$29.95**

PC- DRIVEN ELECTROCARDIOGRAM

This simple project will let you take your own electrocardiograph, and display it on a PC. With the software supplied, you can read, display, save to disk and print the electrical waveform generated by your own heart (or anyone else's). Powered by a 9V battery and electrically isolated from the computer, the PC-ECG is a safe, low cost way to monitor the electrical activity of the heart

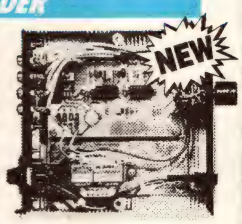
NEW

EA ***JULY '95***

K10680 **$29.95**

ECONOMY SURROUND SOUND DECODER

Perhaps your budget can't quite stretch to the cost of a full "bells and whistles" Dolby Pro-Logic surround sound decoder. Or alternatively, you might be one of those music lovers who doesn't like the idea of subjecting your favourite music to a lot of fancy digital processing. Either way, this really low cost Halfer-type analog decoder should appeal to you.



NEW

EA ***May '95*** K10670 ***$59.95***

A PHOTOGRAPHIC TIMER FOR DARKROOMS

If you are looking for an accurate way to control film developing times, then take a look at this Photographic Timer. It will switch on mains-powered fluorescent ultraviolet tubes or incandescent lamps rated at up to 1200W for a preset time ranging from 1 - 450 seconds.

Silicon Chip April '95

NEW

K10665 **$64.95**

DIGITAL TRIGGER ADAPTOR FOR SCOPES

K10660 **$68.95**

With eight inputs (expandable to 24), this useful device will monitor almost any digital circuit and trigger your oscilloscope only when a preset combination of inputs is found. It also includes an adjustable triggering delay, so it can effectively convert your scope into a low cost logic analyser. EA ***April '95***

KITS KITS KITS KITS KITS KITS KITS

CAT	Description	R.R.P
K10005	SOLAR VOLTAGE REGULATOR	$13.95
K10040	ETI 480 50W AMP	$27.95
K10045	ETI 480 100W AMP	$34.95
K10050	ETI 480 POWER SUPPLY	$28.95
K10060	BALANCED MICROPHONE AMPLIFIER	$12.95
K10065	GENERAL PURPOSE AMPLIFIER	$14.95
K10070	BALANCED INPUT DIFFERENTIAL PREAMP	$19.95
K10075	FLOAT NICAD CHARGER	$14.95
K10080	TRANSISTOR TESTER	$22.95
K10085	300W PLAYMASTER AMP	$119.00
K10095	2 TONE ALARM	$9.95
K10100	1.5V TO 9V DC CONVERTER	$11.95
K10105	3 DIGIT COUNTER	$22.95
K10110	ELECTRIC FENCE	$23.95
K10115	ELECTRIC FENCE CONTROLLER	$61.95
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K10160	THERMOSTATIC SWITCH FOR RADIATOR FANS	$31.95
K10165	I/O ADAPTOR FOR PC's	$59.95
K10170	INPUT BUFFER & RELAY DRIVER	$34.95
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K10205	VHF POWERMATCH	$74.95
K10215	TEMPERATURE PROBE FOR MULTIMETERS	$19.95
K10225	18V / 1AMP BENCH TOP POWER SUPPLY	$79.95
K10260	INVERTER 2KW (NON ASSEMBLED)	$1,495.00
K10265	INVERTER 2KW ASSEMBLED & TESTED	$1,895.00
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K10300	TEMPERATURE ADAPTOR	$24.95
K10305	VOICE OPERATED RELAY	$19.95
K10310	IGNITION KILLER	$22.95
K10315	HEADPHONE AMPLIFIER	$34.95
K10320	VIDEO RF MODULATOR	$17.95
K10325	50W AUDIO AMPLIFIER	$54.95
E10325	PCB 50W AUDIO AMPLIFIER TDA1514A	$19.95
K10330	RS232 FOR COMMODORE 64	$24.95
K10335	RGB TO PAL ENCODER MODULE	$49.95
K10340	CAMCORDER MIXER	$29.95
K10345	KARAOKE BOX	$28.95
K10350	REMOTE CONTROL EXTENDER FOR VCRS	$32.95
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K10500	VOICE OPERATED AUDIO SWITCH	$12.95
K10505	SIMPLE LED CHASER	$19.95
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K10515	SOUNDS & LIGHTS FOR LEVEL CROSSING	$34.95
K10520	AN IMPROVED DSO ADAPTOR FOR PC'S	$158.95
K10521	DSO ADAPTOR (INCLUDES ADC0861)	$168.95
K10525	WEEKLY REMINDER TIMER	$19.95
K10530	L/NOISE UNI. STEREO PREAMP	$19.95
K10535	LIGHT & SOUND TRIGGER	$41.95
K10540	50W AUDIO AMPLIFIER	$37.50
K10545	IND. METAL BALANCE DETECTOR	$58.95
K10550	FAST CHARGER FOR NICAD	$42.95
K10555	DUAL ELECTRONIC DICE	$24.95
K10560	DIGITAL VOLTMETER FOR CARS	$39.95
K10565	DIGITAL TACHOMETER FOR CARS	$49.95
K10570	COOLANT LEVEL ALARM	$29.95
K10575	STEAM TRAIN WHISTLE & DIESEL HORN SIMULATOR	$22.45
K10580	BUDGET PRICED TEMPERATURE CONTROL	$39.95
K10585	HIGH-POWER DIMMER FOR INCANDESCENT LAMPS	$69.95
K10595	NICAD ZAPPER	$29.95
K10600	GO/NO-GO CRYSTAL CHECKER	$18.95
K10605	CHAMP PRE-AMP	$8.95
K10610	MINIVOX VOICE OPERATED RELAY	$13.95
K10615	LONG-WAVE AM RECEIVER FOR AIRCRAFT WEATHER INFORMATION	$37.50
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K10630	TALKING HEADLIGHTS REMINDER	$62.95
K10635	BEGINNER'S VARIABLE DUAL-RAIL POWER SUPPLY	$39.95
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K10645	3-SPOT LOW DISTORTION SINEWAVE OSCILLATOR	$49.95
K10650	A BUDGET PRICED "SHOESTRING" STEREO AMP	$99.95
K10655	DIGITAL EFFECTS UNIT FOR MUSICIANS	$138.95
K10660	DIGITAL TRIGGER ADAPTOR FOR SCOPES	$68.95
K10665	A PHOTOGRAPHIC TIMER FOR DARKROOMS	$64.95
K10670	ECONOMY SURROUND SOUND DECODER	$59.95
K10675*	LOW COST TRANSISTOR TESTER/MOSFET	$29.95
K10680*	PC- DRIVEN ELECTROCARDIOGRAM	$29.95
K10685*	IMPROVED FLEXITIMER MK2	$22.95
K10690*	LED BATTERY VOLTAGE INDICATOR	$12.45
K10695*	JACOB'S LADDER DISPLAY (Without Coil)	$29.95
K10696*	JACOB'S LADDER DISPLAY (With Coil)	$59.95

*SOON AVAILABLE

SCKITSEP-AUG95S

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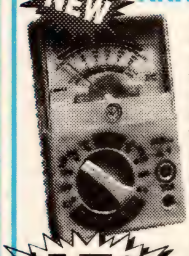
MASSIVE SAVINGS ON ITEMS THAT YOU SHOULD INCLUDE IN YOUR TOOL BOX!! COME TO RIE FOR THE BEST BARGAINS!

NEW ANALOGUE MULTIMETER



A pocket sized multimeter that includes 5 functions and 16 measuring ranges. Single knob function control makes it very simple to use. Comes complete with test leads and instructions and is ideal for the handyman - can be kept in the glove box of the car.

SPECIFICATIONS

DC Voltage: 0-2.5-10-50-250-500 volts
AC Voltage: 0-10-50-250-500 volts
DC Current: 0-500µA-10mA-250mA
Resistance: Rx10, Rxl k (centre 3.6)
Battery Test: 1.5V 9V
Sensitivity: 2k ohms/volt DC/AC
Power: Requires 1 x AA battery

$17.95
Q13060

NEW DIGITAL MULTIMETER

The ideal meter for technicians with a full 3½ digit LCD readout. Requires a 9V battery either alkaline or carbon. Expected life of carbon battery is 100 hours and 200 for the alkaline.

SPECIFICATIONS

DC Voltage: 200mV-2-20-200-1000 volts
AC Voltage: 200-750 volts
DC Current: 200µA-2000µA-20mA-200m A-10A
Resistance: 200Ω-2000Ω-20kΩ-200kΩ 2000kΩ
Diode Test: Measures forward resistance in kΩ with a test current of 1.5mA max
Power: Requires 1x 9V battery

$37.95
Q13070

DIGITAL MULTIMETER

The ideal meter for technicians with a full 3½ digit LCD readout. Requires a 9V battery either alkaline or carbon. Expected life of carbon battery is 100 hours and 200 for the alkaline.

SPECIFICATIONS

DC Voltage: 200mV-2-20-200-1000 volts
AC Voltage: 200-2-20-750 volts
DC Current: 200µA-2mA-20mA-200mA-2A-20A
AC Current: 200µA-2mA-20mA-200mA-2A-20A
Resistance: 200Ω-2kΩ-20kΩ-200kΩ-2MΩ-20MΩ
Diode Test: Measures forward resistance in kΩ with a test current of 1.5mA max
Power: Requires 1 x 9V battery

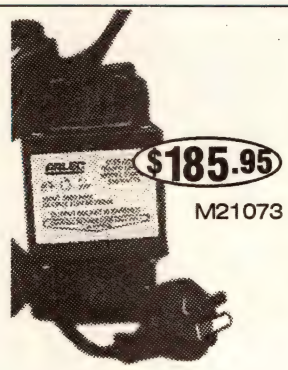
$59.95
Q13080

ARLEC STEPDOWN TRANSFORMERS

Stepdown Transformers are designed to allow appliances designed for 110V to 120V to be operated from 240V mains

FEATURES:

- Protective earth carried through to output
- Earthed 3 pin output socket
- Replaceable fuse for overload protection
- Carry handles
- Safe robust construction



$185.95
M21073

MODEL 2166-ST 250 WATT
INPUT 240V 50Hz OUTPUT 115V AC 250VA

$98.95
M21071

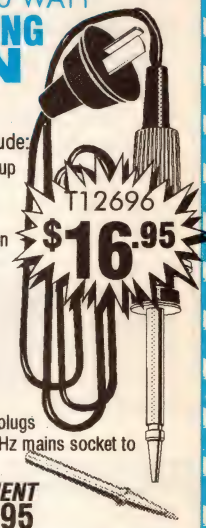
MODEL 2164-ST 100 WATT
INPUT 240V 50Hz OUTPUT 115V AC 100VA

BUDGET 30 WATT SOLDERING IRON

Budget-priced soldering iron.Features include:

- Super quick heat up & recovery times.
- 30 watt power.
- Lightweight design for high work rate & productivity.
- Long tip life - replaceable.
- Maximum temperature 330 degree Celcuis.

This soldering iron plugs into any 240VAC/50Hz mains socket to operate.



T12696
$16.95

TIP REPLACEMENT
T12698.....**$9.95**

PENTIUM™ COMPUTER FAN

Suit 90MHz cpus

H10612.
$24.95

PENTIUM™ COMPUTER FAN

For 60/66MHz cpus

H10613
$24.95

NEW BNC PANEL MOUNTING PLATE

These plates have the BNC punched holes made out of plastic

BNC WALL PLATE SINGLE
$5.00
Y16084

BNC WALL PLATE DOUBLE
$5.00
Y16082

240VAC MAINS SURGE PROTECTION AND FILTER X10092

SAVE $21.00
WAS $70.98
NOW $49.95

- *Approved by the Australian Dept of Minerals & Energy.*
- *Approval # N11361*

SOMETER9

COMPUTER FAN

The easy way to cool your CPU

GREAT PRICE!!
FOR 486 CPU
H10611
$14.95

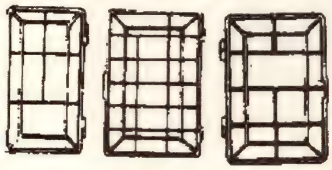
SOLDER ROLLS

Don't be fooled by cheap imports. Solder has to have the correct flux or else your soldering iron tip will corrode.

	WAS	NOW
60/40 RESIN CORED:		
0.71MM, 250Grams T31000	$8.95	$7.95
0.71MM, 500Grams T31002	$15.95	$13.95
0.91MM, 250Grams T31010	$7.95	$6.95
0.91MM, 500Grams T31012	$14.95	$12.95
1.6MM, 250Grams T31020	$7.50	$6.05
1.6MM, 500Grams T31022	$15.95	$12.95
HOBBY PACKS- 60/40 Resin cored in 1 metre lengths		
0.71MM T31030	$1.50	
0.91MM T31032	$1.25	
1.6MM T31034	$1.00	

HANDY COMPONENTS HOLDERS

Use these handy compartmentated boxes to store all your bits and pieces of electronic components, parts and other stuffs for easy access. Each one is made of robust opaque plastic and have hinged "snaplocking" lid.



FIVE COMPARTMENT PART BOX
One large and four small individual sections. 172W x 90D x 38H mm
H10088 .....**$5.95**

SEVEN COMPARTMENT PART BOX
One large and six small individual sections. 180W x 118D x 42H mm
H10089 .....**$6.95**

SEVENTEEN COMPARTMENT PART BOX
One large and sixteen small individual sections. 270W x 173D x 40H mm
H10090 .....**$9.95**

TWENTY-SIX COMPARTMENT PART BOX
Twenty-six storage sections. 274W x180D X 43H mm
H10092 .....**$11.95**

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SOLDER STATION

A new red-hot item. Perfect addition for the electronic workshop.

Solder Station plugs into any 240VAC/50Hz mains socket to operate. The soldering iron functions at 12-18VAC 6W.

Features include: ● Heating temperature of up to 319 degrees Celsius. ● PTC (Positive Temperature Co-efficient)controlled to maintain consistent tip temperature. ● Fast warmup time. ● Heating temperature of up to 319 degrees Celsius. ● Longer Tip Life.

T12566 ~~$54.95~~
Save $25 -$29.95

Stock/Tip replacement-
T12697.....**$9.95**

ALL NEW

PCI VGA CIRRUS LOGIC 5430

X18183 $169

1MB DRAM FITTED

An all new PCI VGA card based on the Cirrus Logic 5430, that is specficially designed for the Pentium 75MHz and above family of CPUs. Upgrade to higher video display performance with the drivers support and utilities.

Features

- Fully IBM VGA compatible
- Support VESA standard software by BIOS built-in functions
- Support PCI-33MHz (2.0) system with Burst mode
- 64-bit GUI acceleration (32-bit for 5430)
- 64 x 64 hardware cursor
- Support 72Hz vertical scan refresh rate
- VESA standard feature connector
- Built-in clock chip and a true colour (24bit, 16 million colours) RAMDAC
- 64-bit memory data bus support up to 4MB DRAM (2MB for 5430 and5434PCI/SMT model)
- Green PC support including DPMS-compatible BIOS, jumper for light-greenmotherboard and power-saving utilities
- Support VGA, SuperVGA, and Enhanced VGA resolution in 16, 256, 64Kand 16.7 Million simultaneously colours

DISPLAY UP TO 1280 X 1024 256 COLOURS WITH OPTIONAL 2MB

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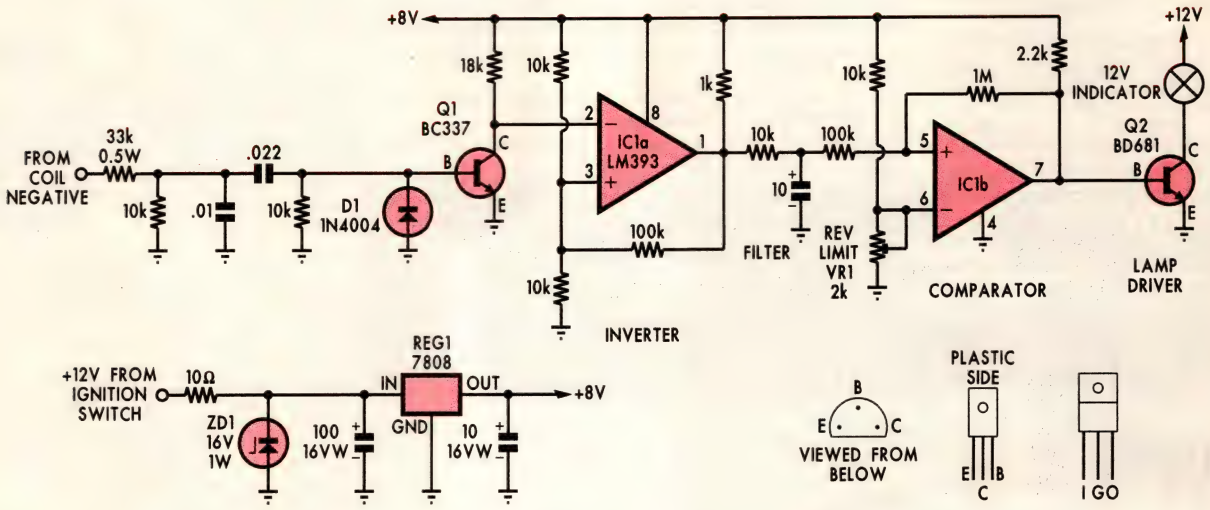
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Rev limit indicator for rally cars

For racing and rally vehicles, knowing precisely when to change gear can give you the edge in competition. While a tachometer will give a reliable indication of the engine revs, it is not always easy to read when there is a lot of action going on outside the windscreen.

This rev limit indicator will provide a warning light above a preset RPM. The light is located in a position which is instantly noticed by the driver, so that the gear changing point can be indicated without looking at the tachometer.

The circuit takes the RPM signal from the negative (switched) side of the ignition coil. This means that the circuit will operate from any type of ignition system whether driven by points, Hall Effect sensor, reluctor or optical pick-up.

The 33kΩ and 10kΩ resistors divide the voltage from the coil and high frequency spikes are suppressed with a .01μF capacitor. The signal is then AC-coupled to the base of transistor Q1, while diode D1 clamps negative swings of the input signal.

The collector of Q1 will normally be high and will go low whenever the coil fires. Q1's pulse output is inverted by IC1a, a comparator connected as an inverter. Pin 3, the non-inverting input, is referenced to about half the supply voltage using two 10kΩ resistors across the 8V rail. A small amount of positive feedback is applied to pin 3 using the 100kΩ resistor from pin 1. This increases the hysteresis to prevent high frequency oscillation at the switching point.

A 1kΩ resistor is used as a pullup between pin 1 and the +8V rail since these comparator outputs are open collector. A 10kΩ resistor and 10μF capacitor filter the signal from pin 1.

The higher the engine RPM, the higher the filtered voltage which is fed to pin 5 of comparator IC1b. Here, the reference voltage for the inverting input (pin 6) is set by the 10kΩ resistor and trimpot VR1, which determines the rev limit. When the output of IC1b output goes high, at the rev limit, transistor Q2 is turned on to drive the indicator lamp.

The circuit is powered via an 8V regulator which is protected against voltage transients using a 10Ω resistor and 16V zener diode. Note that the lamp is powered directly from 12V rather than the 8V regulator output.

VR1 is adjusted so that the lamp lights at the desired gear change point.

SILICON CHIP

Car courtesy light monitor & extender

This circuit monitors the on-time of your car's interior light. If the car door is left ajar, the light will be switched off after a preset time. This prevents an "early-morning" flat battery due to the interior light(s) being left on all night because a door has not been shut properly.

In addition, an on-time extender has been incorporated into the circuit. This ensures that the interior light stays on for seven seconds after the door has been shut.

When the car door is opened, S1 closes and capacitor C1 begins to charge via R4 (1MΩ). At the same time, pin 3 of IC1a is pulled low and so its output at pin 4 switches high. This in turn holds Mosfet Q1 on via D2, inverter IC1d and paralleled inverters IC1e & IC1f. Q1 in turn drives the courtesy lamp.

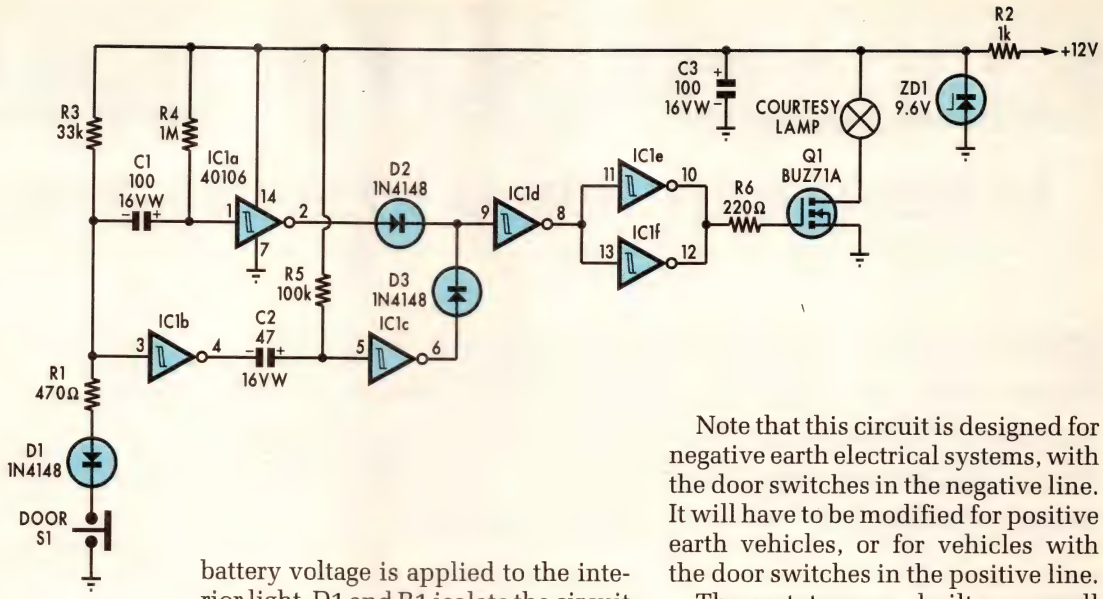
If the door is left open, C1 continues charging and eventually pin 1 of IC1a is pulled high. When this happens, pin 2 of IC1a switches low and Q1 and the courtesy lamp turn off (after approximately 70 seconds).

IC1b, IC1c and their associated parts provide the on-time extension feature.

When the door is opened, pin 3 of IC1b is also pulled low and so its output (pin 4) switches high and discharges C2. When the door is subsequently shut, pin 4 of IC1b goes low again and C2 begins charging via R5.

During C2's charging period, the input to IC1c is low and so its pin 6 output is high. This holds Q1 on via D3, IC1d, IC1e & IC1f. When C2 charges, after about seven seconds, pin 6 of IC1c switches low again and Q1 turns off.

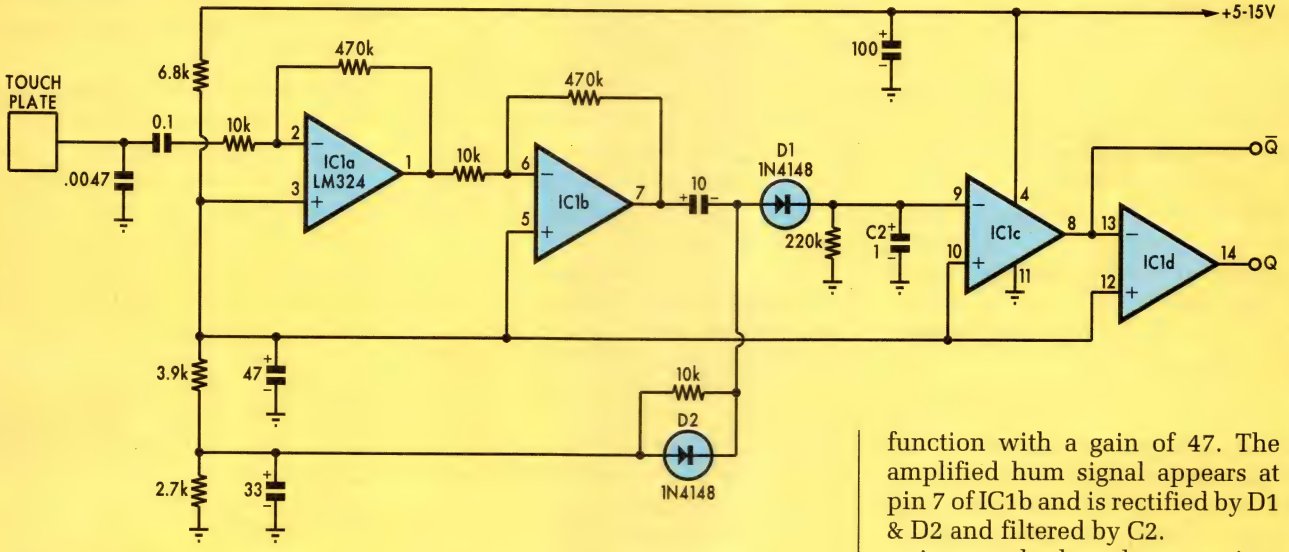
A BUZ71A power Mosfet is used as the switch to reduce heat dissipation and to ensure that virtually the full battery voltage is applied to the interior light. D1 and R1 isolate the circuit from any other circuitry (eg, a door ajar alarm), while R2, C3 and ZD1 filter spikes from the vehicle's electrical system that might cause false triggering or destroy the IC.



Note that this circuit is designed for negative earth electrical systems, with the door switches in the negative line. It will have to be modified for positive earth vehicles, or for vehicles with the door switches in the positive line.

The prototype was built on a small piece of veroboard. This was wrapped in insulation tape and installed in the roof lining, next to the interior light.

D. Harvey,
Stanthorpe, Qld. $30



Touch sensitive switch uses a single IC

This simple circuit uses one quad op amp (IC1a-IC1d) and a few minor components to make an effective touch sensitive switch.

As shown in the circuit, the non-inverting inputs of all the op amps are biased to half the supply voltage (ie, ½Vcc). At the same time, the DC bias at the inverting input of IC1c (pin 9) is considerably less than this figure. This bias is derived from the junction of the 3.9k and 2.7kΩ resistors and is applied to pin 9 of IC1c via a 10kΩ resistor and diode D1.

IC1c is wired as a comparator. As a result, its pin 8 output is normally switched high and so pin 14 of comparator IC1d is normally low.

When a finger is applied to the touch plate, the increased hash and hum is greatly amplified by op amp stages IC1 & IC2. These two inverting amplifier stages both function with a gain of 47. The amplified hum signal appears at pin 7 of IC1b and is rectified by D1 & D2 and filtered by C2.

As a result, the voltage on pin 9 of IC1c now exceeds the bias on pin 10 and so pin 8 of IC1c switches low. This in turn means that pin 14 of IC1d switches high. This output can be used to turn on a transistor to drive a relay or sound a buzzer, or used directly to switch external circuitry.

The resistors across D2 & C2 increase the settling rate and make for cleaner switching. The switching time is approximately 100µs.

Bill Jolly,
Tranmere, SA. ($30

SERVICEMAN'S LOG

What's happened to service backup?

I have a rather mixed bag this month, ranging from an el cheapo, downmarket TV set to an all-singing, all-dancing, state-of-the-art model with more bells and whistles than are ever likely to be used. Neither set was an easy exercise.

The first story concerns a 34cm portable colour TV set made in China and marketed under the Vision brandname (model VIS-146R). It is not only a story of technical problems, although it has its share, but also one of woefully ineffective backup and support for imports from this part of Asia. More on that later.

The technical problem, as described by the owner, was simply a form of frame collapse or, as he put it, "after the set's been running for a while, a black band comes down from the top and up from the bottom."

Well, there's nothing new about a complaint like that. And, while I had no data of any kind for this set – it was the first one I had seen – I didn't imagine that it would a particularly difficult fault to fix.

On the bench, the set behaved exactly as the owner had said. It performed normally for about 10 or 15 minutes then suddenly went into the fault condition. Fortunately, even without a circuit, the vertical system appeared to be fairly conventional and based on a 7-pin IC (IC205, a TA8403K). After taking some voltage measurements around this IC, in both the normal and fault conditions, and checking associated components, I concluded that the IC was faulty.

Unfortunately, my regular spare parts supplier did not list this IC, so I approached another organisation who were supposed to be the agents for this set. And this was the first hurdle. When I identified the set and nominated the IC type number, I was promptly informed that that IC was not fitted in that set.

And in vain did I emphasise that I had the set on the bench and the IC in my hand. "Aw no, it can't be", was the only response I could get. There followed quite an argument, which culminated in a grudging offer to investigate and ring me back.

Of course they didn't and I had to follow up with several more phone calls, only to be shoved around from technician to storeman and back again. The upshot was that, while tacitly admitting that I had correctly quoted the number in the set on my bench, they suggested a substitute unit, LA7830. And they quoted a price of something over $20.

I said, "thank you very much; I'll let you know". And there was a very good reason why I didn't immediately place an order. I was familiar with the LA7830 and I knew that my regular supplier stocked it. More importantly, he listed it at about half the quoted price.

So the replacement IC was duly acquired and fitted. And that fixed the fault; the set came good immediately. I gave it a thorough workout for the next week or so (the owner had stressed that he was not in a hurry) and, in view of subsequent events, I was very glad I did.

During the test week, however, it didn't miss a beat, in spite of all the abuse I could heap upon it. And so it was duly collected by the owner.

That was the last I heard of it for the next couple of months. Then the owner was on the phone with the bad news; the set had failed again with the same fault. He was quite reasonable about it – almost apologetic – but it was a bit of a shock to have the set bounce. I asked him to bring it in immediately.

On the bench, the set did appear to be exhibiting the same fault – at least superficially. And it even fooled me at first. But it wasn't exactly the same. I recalled that the original fault had been quite predictable in its onset; it would appear every time within 10 or 15 minutes of switch-on.

Not so now. Sometimes the set would run perfectly for hours, then suddenly go into fault condition. At other times it was in fault condition at switch-on. My suspicions aroused, I made a check around the previous culprit, IC205. There were none of the voltage changes which had lead me to this component before.

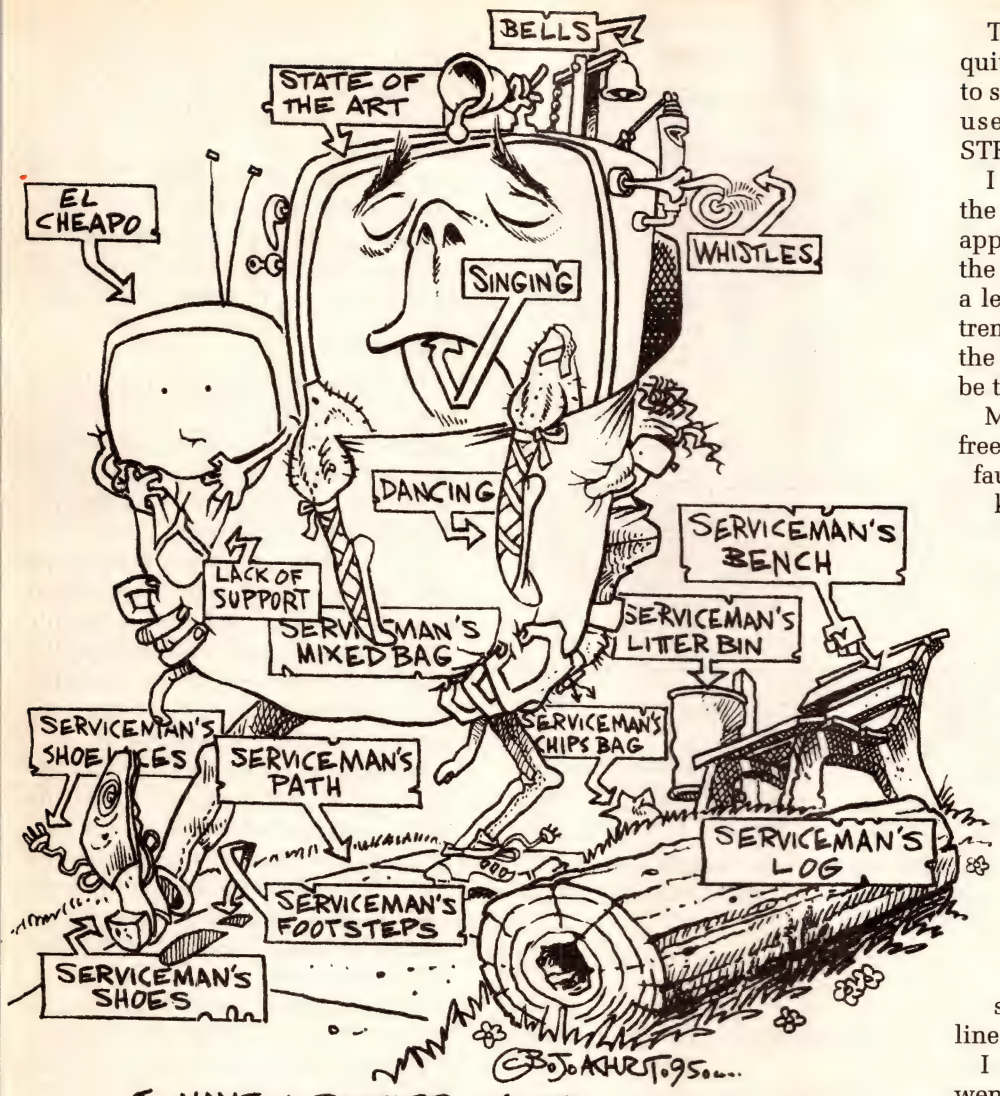
But there was one change, not evident on the previous occasion. The supply rail to the IC was normally 25V but now, in fault condition, it dropped by about 3V. Another IC fault? Not very likely I felt, since the IC gave no sign of overheating. So was it a fault in the power supply, or somewhere along the line to the IC?

That was probably the explanation but it was time to call a halt. I wasn't prepared to go any further without some service data – a circuit diagram at the very least.

A sorry tale

And that brings me to hurdle number two – and a sorry tale it is. I approached the aforementioned agents and asked what they could provide. The best they could offer was a circuit diagram. I was prepared to settle for this and they promised to send one.

When it didn't arrived in a reasonable time, I rang them to see what the problem was. They made some vague excuses about a shortage but my impression was that they had forgotten all about it. They promised to chase it up but it still didn't arrive and further phone calls over several weeks pro-



duced further vague excuses.

Finally, after some fairly straight talking on my part, a circuit arrived. But – you've guessed it – it was the wrong circuit. In fact, it was nothing like the set on the bench. It took several more phone calls (and related excuses) before the correct circuit turned up – for what it was worth.

My guess is that it was about a 10th generation photocopy, made via a couple of pretty grotty copying machines along the way. It was almost completely unreadable with component values, type numbers, identification symbols, voltages (such as there were) IC pin numbers and any lettering all just blobs.

The best I could do was try to relate actual component type numbers or values with the blobs on the circuit and see whether they seemed to match. In most cases, it was guess work more than anything. And that was all I had to work with.

Granted, it was better than nothing, in the sense that I could at least follow the general circuit trend which all seemed fairly conventional. Well, that was something.

Power supply checks

So back to the fault. Following up the lowered 25V rail clue, I checked the main HT rail. With the set running normally, it sat at about 120V but in fault condition, this dropped to around 93V, although this figure varied somewhat.

OK, so we had a main power supply fault. And this fitted in with another earlier observation. When the vertical deflection decreased, so did the horizontal scan (though less obviously) – something that suggested a common fault.

The power supply appeared to be quite conventional and very similar to some used in Samsung sets. And it used the same common IC, an STR5404. Well, that was a small plus.

I turned the set on and waited for the first sign of the fault. When it appeared, I began prodding around the board, hoping to get some kind of a lead. And I did; the board was extremely sensitive, particularly around the IC. In fact, the IC itself appeared to be the most sensitive.

My next trick was to try a spot of freezer on the IC while the set was in fault condition, taking great care to keep the freezer off any other components. Result – an instant cure. And it worked every time.

I carry this IC in stock and, with only five pins involved, it took only a few minutes to fit a new one. My self-confidence was shattered immediately at switch – there was absolutely no improvement. In fact, I soon established that I could cure the fault by spraying the new IC or any component on the board. I was back to square one.

Well, not quite. All these observations added up to a strong suggestion of a dry joint or a hairline crack in a copper track.

I pulled the board out again and went over the copper side with a magnifying glass. And in spite of a careful inspection, I could find nothing even vaguely like a faulty joint. But there had to be a fault in there somewhere, so I decided on a brute force approach – go right over the board and resolder every joint. Yes, I know, it takes time and may also dent one's ego a little but it is often the most effective approach.

And it certainly was in this case. It took me about 20 minutes to do the job – and I could have spent more time than that just prodding and pondering – and it cured the fault. And when all is said and done, that was the purpose of the exercise.

Another intermittent

Naturally, I gave the set a good workout over the next few days and nothing I could do would produce the fault. But it wasn't the end of the story. During this procedure, I became aware of another fault – also intermittent – which the owner had appar-

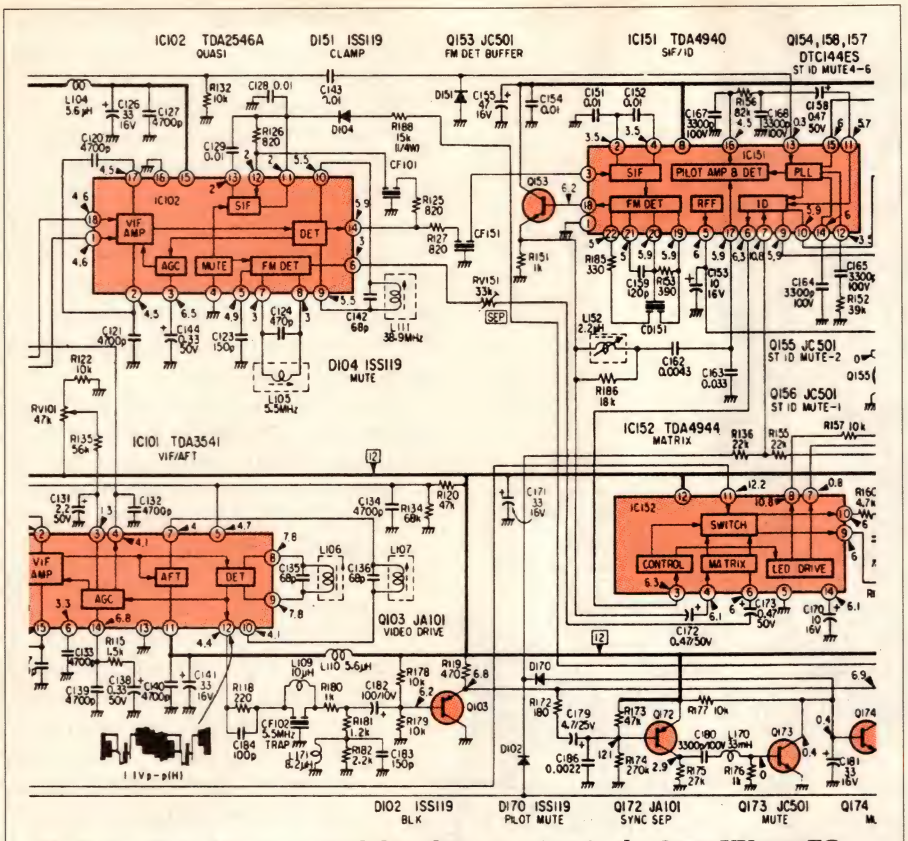


Fig.1: the IF and stereo sound decoding circuitry in the Sony KV2764EC. IC102, which contains the FM detector, is at top left, with L111 between pins 9 & 10 and L105 and C124 between pins 7 & 8.

ently not noticed and which I hadn't noticed either in the confusion associated with the original fault.

Now that I could watch the screen in a more relaxed manner, I suddenly became aware that there was a loss of blue in the picture from time to time. The effect could be somewhat subtle at times, depending on the overall colour content, but it was definitely happening.

This part of the circuit is quite conventional. Three drive transistors – red, blue and green – on the neck board feed the three picture tube cathodes and, in turn, are fed from the PAL decoder IC on the main board.

My first reaction was to suspect the blue drive transistor. This is a common type, a BF422, and it was easy enough to replace it with one from stock. But no joy, the fault remained.

Next, I checked the voltages, particularly the base voltages, around all three transistors, first while the set was normal, then when the fault appeared. Under normal conditions the reading on all three bases was about 4V but, in the fault condition, this was something less the 2V on the blue base.

The base of this transistor connects to a 2.8kΩ trimpot, used for colour balance adjustment, and from there to the main board and the PAL decoder blue output. However, there are two more components in the line: a small RF type choke and a 100Ω resistor.

Tracing this line showed the low voltage at the connection to the main board but the correct voltage at the PAL decoder. By then retracing the line from the decoder, I found the correct voltage up to and beyond the 100Ω resistor but not beyond the choke.

I checked the choke's soldered joints very carefully but they appeared to be perfect. Nor could I find anything wrong with the choke when I pulled it out and tested it. As a result, I refitted the choke, this time taking particular care with the soldering.

And that was it. It took me several days of constant monitoring to be quite sure but the fault was fixed. And it has remained fixed for several months now.

So I hope that is the last I shall see of that set or any of it brethren. In fact, another one turned up a few weeks later but I had to say "sorry, I can't service it". And I went on to explain the problems of obtaining data and other technical backup. And unless those concerned can get their act together, I suspect other servicemen will be forced to adopt the same attitude.

The snack

Well, after all that, a change of pace is called for. Here are some shorter stories; stories I have been holding back for some time, due to space problems. And the first one is something of a reversal of the usual theme.

One of my common themes is the fault which looks like a snack but turns out to be a real stinker. In this case, it was a strange new fault which I thought would be a stinker but which turned to be much easier than I expected, if only by good luck.

It concerns a Sony KV2764EC colour TV set (PE-3 chassis) and the owner complained that there was very little or no sound when operating the VCR, although there was plenty from the channels on the TV set. It had started by being intermittent but was now permanent.

The set was too heavy for the owner to carry it in by himself, so we brought it in together, placed it straight on the bench, and connected a VCR to it in the usual manner. In some perverse way, and in spite of my apprehension, I was actually looking forward to seeing this fault because it sounded like a challenge.

When the owner first mentioned the trouble I had thought he may have connected the VCR incorrectly to the audio and video connections of the 21-pin (SCART) socket on the rear. Or perhaps he suffered from finger trouble and had pressed the wrong buttons on the TV set. But he turned out to be an intelligent bloke, intrigued as much as I was by the fault.

More importantly, he was fortunate enough to have two VCRs. So, when he first noticed the fault, he swapped them around but to no avail. Then he tried swapping the video RF output from Ch1 to Ch0 and retuning the TV set to it. Still no luck. Not only was the sound weak when playing tapes but also when selecting the stations on the VCR's own tuner (sometimes called the EE mode). And, as I soon

~HE TURNED OUT TO BE AN *INTELLIGENT* BLOKE, INTRIGUED AS MUCH AS I WAS BY THE *FAULT*...

discovered, the situation was no better with my VCR which used an RF output on UHF Ch37.

Next I tried using the video-in/audio-in connections via the SCART socket. Ah-ha, plenty of sound, so it must be some sort of RF/IF problem. But why on earth was it discriminating against VCRs? Didn't this set like them or something?

More realistically, what was the difference between an off-air TV station and a VCR? The shape of the sync pulses? No – it took a while but the penny finally dropped. All our TV channels transmit in stereo, using the German Zweiton or two-tone system. But a VCR always transmits in monaural sound, probably because it is too expensive to provide stereo modulation.

So the set was discriminating between a stereo transmission and a monaural one and was muting the latter for some reason. I confirmed this to some extent with an RF signal generator but, not having a stereo generator, I tried attenuating a TV channel until the stereo light went out, which dropped the sound simultaneously.

But where was the fault? Was it in the tuner, IF, stereo decoder, or audio logic circuits? Fortunately, all these areas, except the last, are located on board "A". I decided to start working from the decoder and move out from there. The two intercarrier signals at 5.5MHz and 5.74MHz are fed into IC151 and IC152 where they are decoded.

I began by measuring the voltages around these ICs and found them close to those shown on the circuit. But I was getting a gut feeling that I should concentrate on the 5.5MHz signal which is the usual monaural signal (L+R) rather than the 5.74MHz signal (2R), used for stereo only. This focused my suspicion to IC102 which contains the FM detector.

I decided to hit the components in this area with the hot and cold treatment, on the off-chance of a clue. I was lucky – the freezer momentarily brought the sound up but it quickly disappeared and heating or freezing the components around the IC didn't alter the fault again. I even tried changing the IC, a TDA2546A, but no joy.

I noticed the freezer seemed to have more effect around the end near L111 and L105, where there also happened to be a 470pF styro capacitor C124. I pounced on this because this type of capacitor has a habit of changing its characteristics. I gently squeezed and moved C124 whilst the set was on and was rewarded by a momentary change in sound level. That was enough; I changed it for a new one and the sound was restored.

I phoned Sony technical support on another matter and in the course of the conversation told them about this fault, only to find that this is a common one and the styro is now replaced by the higher grade gold version! I guess I should have phoned them first.

Anyway, the customer was as delighted as I was and departed as happy as a sand-boy. But I have to thank lady luck.

The super Mitsubishi

It wasn't much later when I encountered a similar fault to this involving a Mitsubishi CT-2553EST, fitted with an E4-Z chassis (very similar to the AS-2M chassis). This is one of the newer generation, all bells and whistles, super-deluxe models, boasting just about every feature you can think of, including a multi-standards facility (PAL, NTSC and SECAM).

It's is all very clever but I do wonder how often these features are used, or even understood, by the average person. Of course, it makes for a beaut sales pitch but it means a higher price tag and, more to the point, much greater complexity when trying to service the monster.

And so it was in this case. A major problem in this set is access; trying to take measurements on the main board and the modules while the set is on is a very dodgy procedure. The leads are very tightly dressed in a wiring loom, preventing the board from being easily inverted, while the plug-in modules are just too close together for examination. And to unplug them is a major operation!

Anyway, the complaint amounted to intermittent loss of luminance; ie, a ghostly, over-saturated, dark picture. It was clearly a job for the CRO and we started from pin 10, video out, of the VIF pack, IP1A1, on the main board,

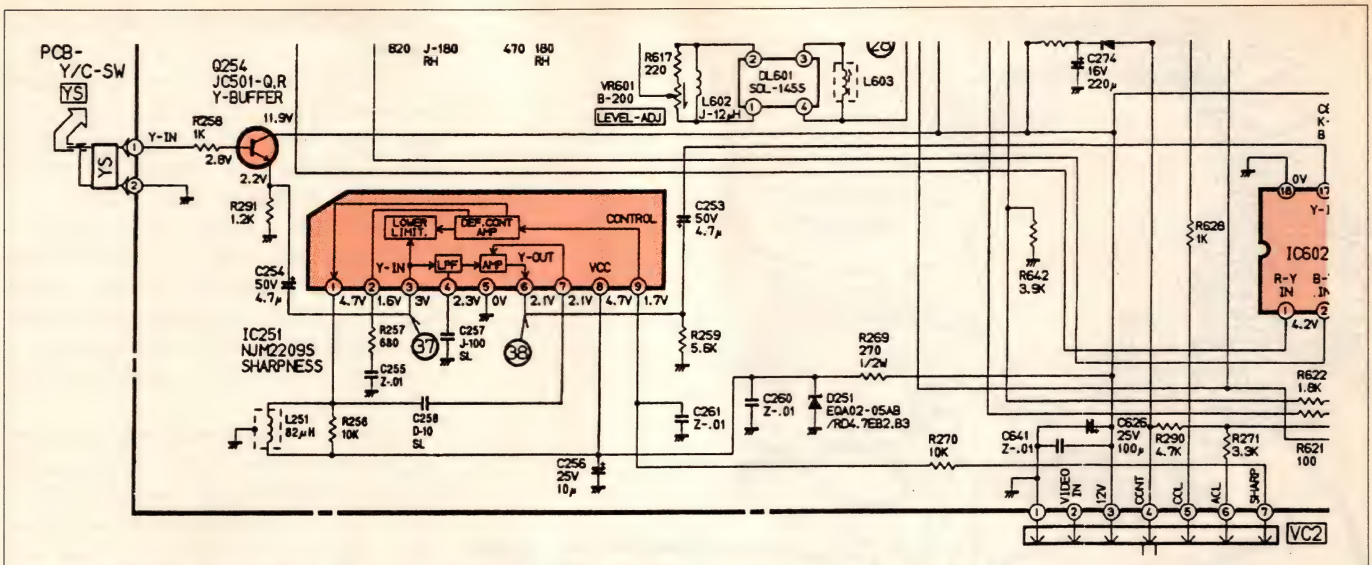


Fig.2: a corroded track in the 12V supply line to transistor Q254 caused the original loss of sound in the Mitsubishi CT2553EST. Note that the 12V rail comes in on pin 3 of socket VC2 at lower right.

PCB-MAIN. There was nothing wrong here, the CRO showing a very clean composite waveform. OK, but which way next?

What follows from here is a bewildering maze of video switching circuits but I managed to trace it, eventually, to PCB-Y/C-SW, via plug/socket VS3, thence through transistors Q2P1 and Q2P2, IC2P1 and Q2P3. From here, despite many blind alleys, I traced the signal to PCB-VC/RGB-CTI via plug/socket YS1 and thence to the emitter of Q254, where the trail became cold, or rather distorted.

The collector voltage of Q254, shown as 11.9V, was very low. This is derived from a 12V rail coming in on plug/socket VC2-3 and which was correct at that point. I was getting close. To cut a long story short, after much bad temper, due to the awkward access to this module, I traced the 12V copper track around the edge of the board.

Near the top, it disappeared under that horrible brown glue which I have mentioned in these notes in the past and which the Japanese are so fond of using to anchor parts. Hasn't anyone ever told them – or don't they listen? I'm still finding this glue in near new sets.

Anyway, as usual, the glue had hardened, changed colour (darkened) and corroded the copper track, changing it, effectively, into a high value resistor. I linked the break and 12V was restored, along with the luminance. It all sounds so simple but it meant taking the module out, measuring and working on it, and replacing it a number of times. This was a very slow and wearisome process .

And that should have been the end of the story. Unfortunately, after reinstallation at its home with its VCR, it bounced. Yes, you've guessed it; intermittent no sound, or rather very little sound, from the VCR.

Unfortunately, I sensed that the owner wasn't very happy. He didn't say much; it was rather what he didn't say that alerted me. It was obviously a different fault, for which I was not to blame, but it was too difficult to argue at that stage.

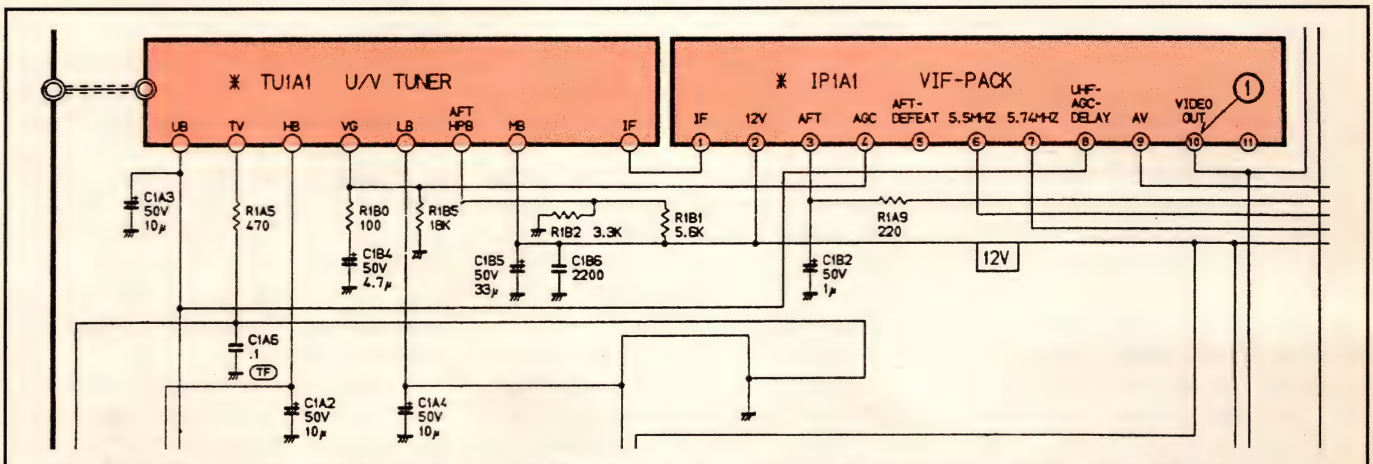


Fig.3: the TU1A1 U/V TUNER and IP1A1 VIF-PACK are only available as a combined pair in the Mitsubishi CT2553EST. The VIF-PACK is prone to dry joints around the filters, coils and the SAW filter.

I confirmed it was OK through the audio/video sockets and I was half-tempted just to supply suitable leads and leave it at that (no, not seriously)! But my reputation was at stake. Since I was – apparently – the one who had wrecked a beloved set, I had to be sure I "fixed it proper"!

As with the Sony, I started at the decoder, located on the PCB-SOUND board, and went straight to IC3001, a TDA3803A. I have had a lot of trouble with the TDA3800G which was used widely on earlier models, especially JVC. But changing this made no difference and I moved to IC3000 and its associated circuitry. I examined this very carefully, particularly capacitor C3002, which plays a similar role to C124 in the Sony circuit. But everything checked out OK and wouldn't succumb to the hot and cold treatment.

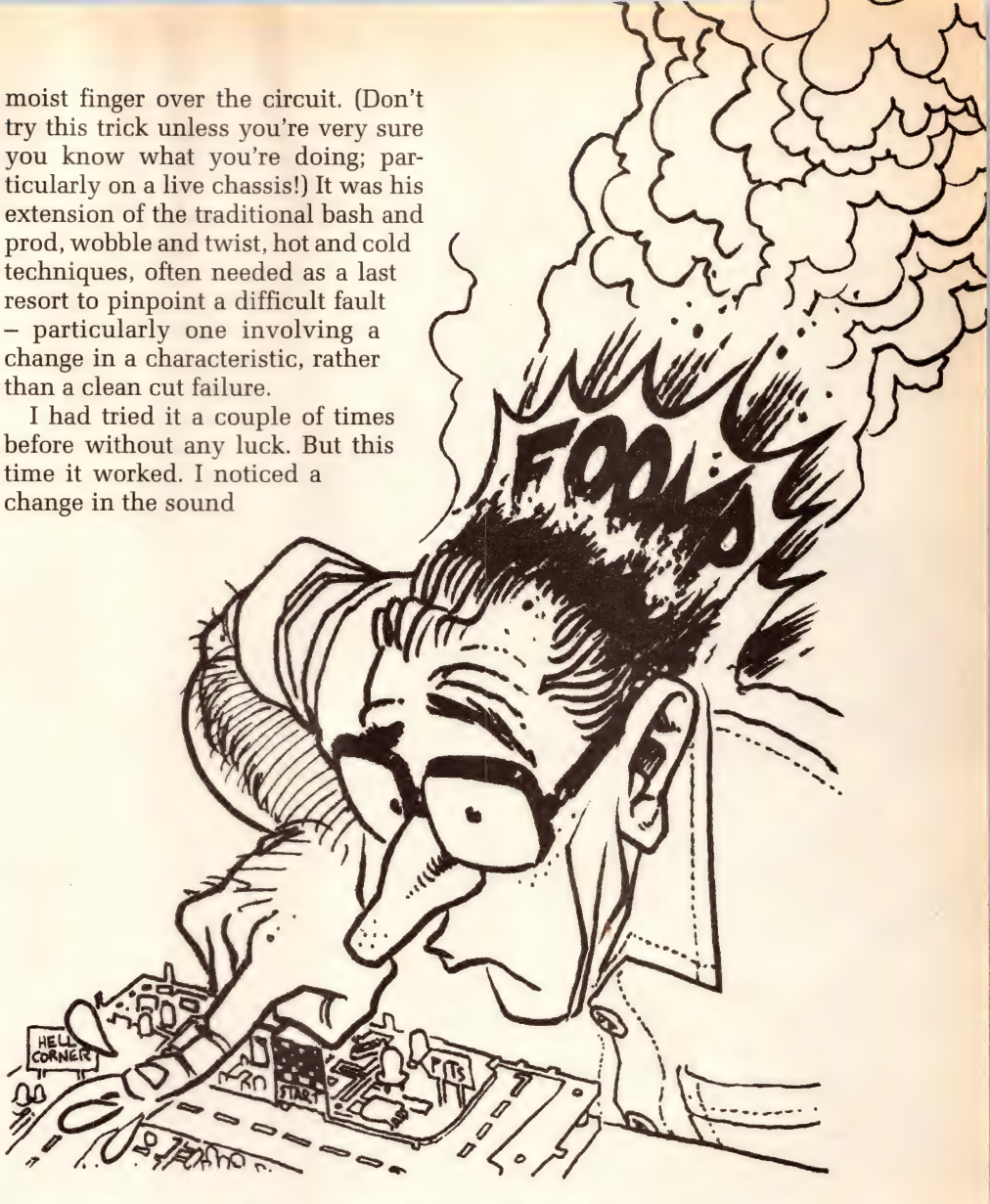
The next major suspect was the previously mentioned VIF-PACK IP1A1. I have had a lot of trouble with this module over the years, including a variety of intermittent faults, mainly video, and everything from no picture to patterning, or snow on UHF only.

And you cannot purchase a new module by itself. Instead, it is part of a (very expensive) matched pair consisting of Tuner TU1A1 and VIF-PACK IP1A1. I unsoldered the module and examined it. Normally, it is very prone to dry joints everywhere but more so around the filters, coils and the SAW filter.

But this set had already been worked over so I reinstalled it with the covers off. I switched the set on and tried freezing the ceramic filters, something that is not usually recommended as it can sometimes damage them. In this case it made no difference.

I then tried a trick I learned from a colleague some time ago; running a moist finger over the circuit. (Don't try this trick unless you're very sure you know what you're doing; particularly on a live chassis!) It was his extension of the traditional bash and prod, wobble and twist, hot and cold techniques, often needed as a last resort to pinpoint a difficult fault – particularly one involving a change in a characteristic, rather than a clean cut failure.

I had tried it a couple of times before without any luck. But this time it worked. I noticed a change in the sound level when touching around the 5.5MHz ceramic filters X3 & X4. The module was removed again and two new filters fitted. And that was it; sweet success – the sound level was back to normal.



THE MOIST FINGER TRICK

Apparently, one of the filters was faulty and off frequency. My finger on the board pattern was re-tuning it slightly. Once again I was lucky.

And, hopefully, my reputation had been restored. **SC**

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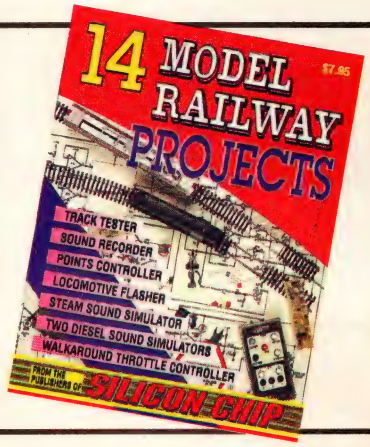
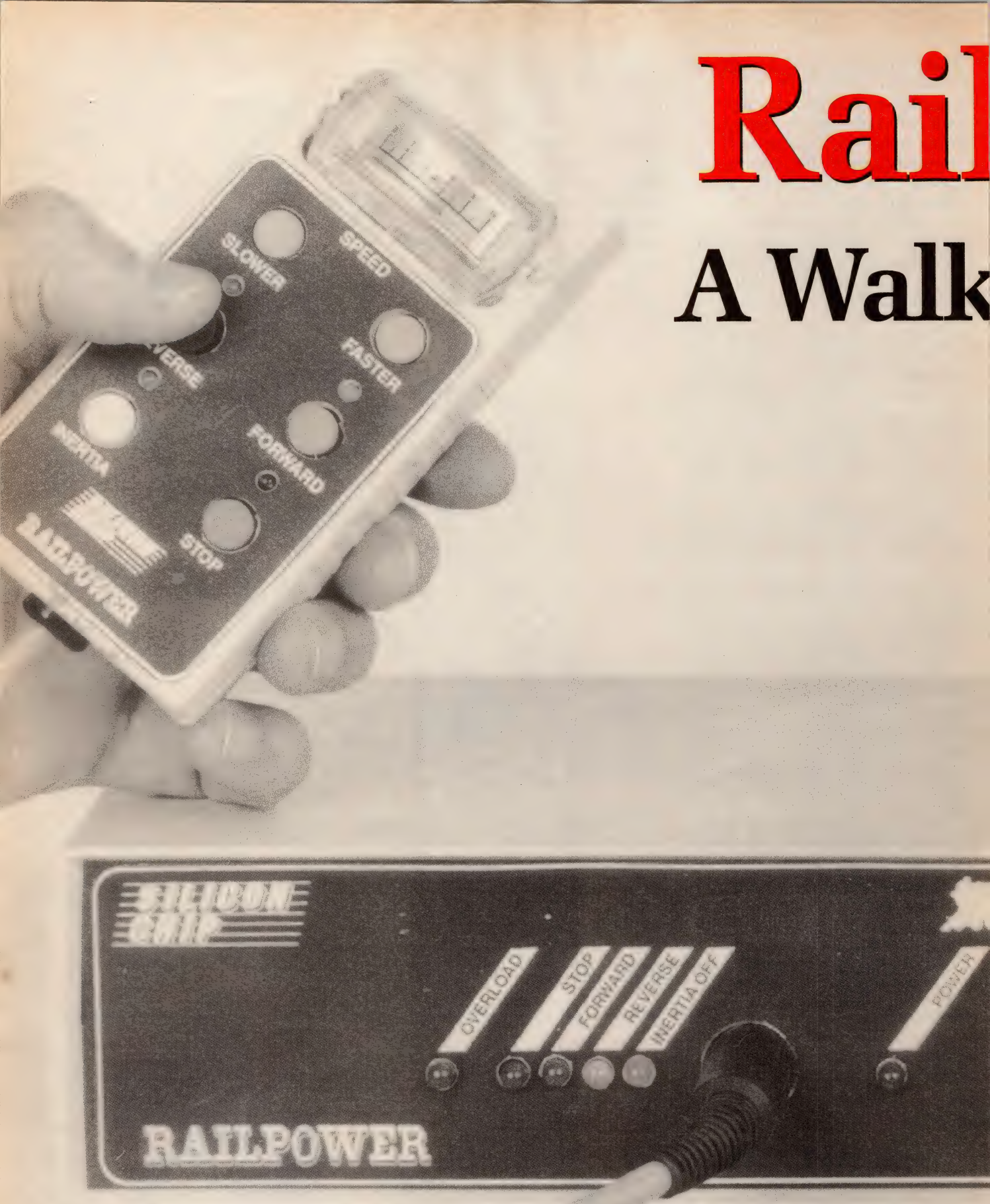


Rail

A Walk


SLOWER
SPEED
FASTER
FORWARD
STOP
SILICON CHIP
OVERLOAD
STOP
FORWARD
REVERSE
INERTIA OFF
POWER
RAILPOWER

power MkII:

Around Throttle For Model Railways

Want to build a walk-around throttle for your model railway? This completely new design offers all the features you could want, including pulse power, pushbutton control, track voltage metering, inertia (momentum) and full overload protection.

By RICK WALTERS

MAIN FEATURES

- Walkaround control with all functions on the handpiece.
- Pulse power for smooth and reliable low speed operation.
- Monitoring of motor back-EMF for excellent speed regulation.
- Inertia (momentum) so model acts as though it had the weight of a real train; inertia can be switched off for shunting.
- Full overload protection, including visible and audible indicators.
- Forward/reverse lockout; prevents train being thrown into reverse until it first comes to a stop.
- Track voltage metering; indicates current speed or ultimate speed setting when Faster or Slower buttons are pressed.

THE RAILPOWER MKII incorporates all the features of our very popular Railpower design featured in April & May 1988. While the original Railpower is still a valid design, the MkII version has a lot of new features. In spite of the extra functions, the new design uses less parts and is easier to build. How can that be? Just read on.

The outstanding feature of our previous Railpower design was the use of pulse power and simulated inertia, allowing the train to move off from rest at a very low speed and accelerate very gradually, which looks very realistic.

Another big feature is the concept of a walk-around throttle. This has all the functions on a hand control and allows you to follow your train all around the layout. Nor do you need a long cable which will get tangled up as you move around. You can have a number of sockets around the layout and you can plug into whichever socket is handy. And when you unplug the hand control in order to move it to another socket, the train carries on at its exact same speed setting, without any disruption.

Hand control

The hand control of the Railpower MkII features a small meter and six pushbuttons. These are labelled Faster, Slower, Forward, Reverse, Inertia and Stop. The latter four buttons have LED indicators to show the selected functions.

The Forward and Reverse buttons are interlocked. If the train is moving forward and the Reverse button is pressed, the Railpower will switch to Stop, the Stop LED will light and the train will slow to a stop. The controller will then switch to Reverse and the Reverse LED will be lit.

A similar sequence occurs if the Forward button is pressed while the train is travelling in the reverse direction. This overcomes a drawback of the original design and all other controllers that we know of – if you mistakenly throw a train into reverse while it is moving at a reasonable speed, it will be derailed.

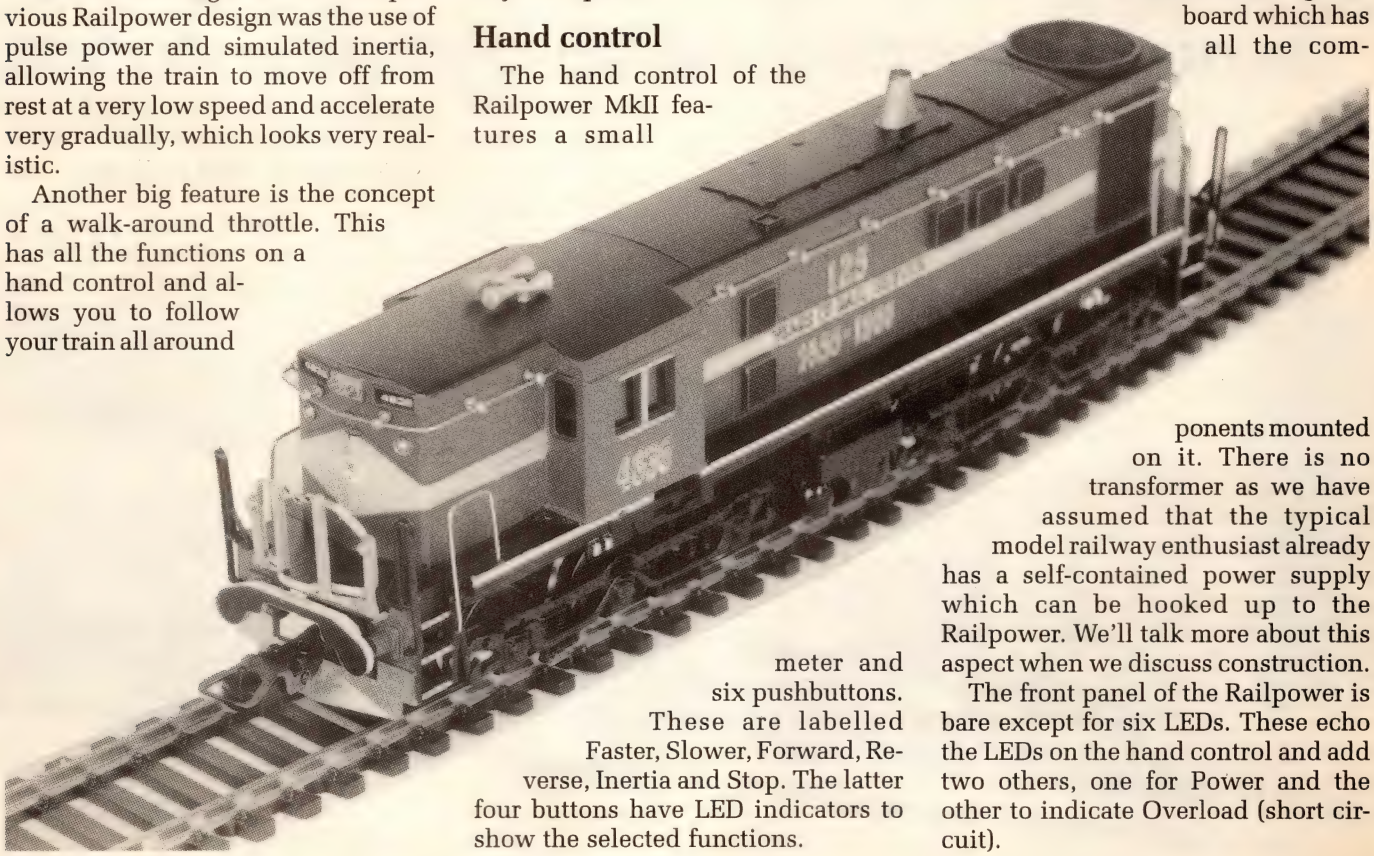
The Stop button, when pressed, will bring the train to a realistic but reasonably rapid halt. The braking time is adjusted by the "brake" trimpot (VR2) on the main PC board.

If you are shunting wagons, the inertia function can be a hindrance. Hence, it can be switched out, by pushing the Inertia button, if the train is stopped or running at a low speed. Once switched out, Inertia can be switched back in at any time.

Railpower controller

Apart from the hand control, the Railpower MkII consists of a plastic case containing a PC board which has all the components mounted on it. There is no transformer as we have assumed that the typical model railway enthusiast already has a self-contained power supply which can be hooked up to the Railpower. We'll talk more about this aspect when we discuss construction.

The front panel of the Railpower is bare except for six LEDs. These echo the LEDs on the hand control and add two others, one for Power and the other to indicate Overload (short circuit).



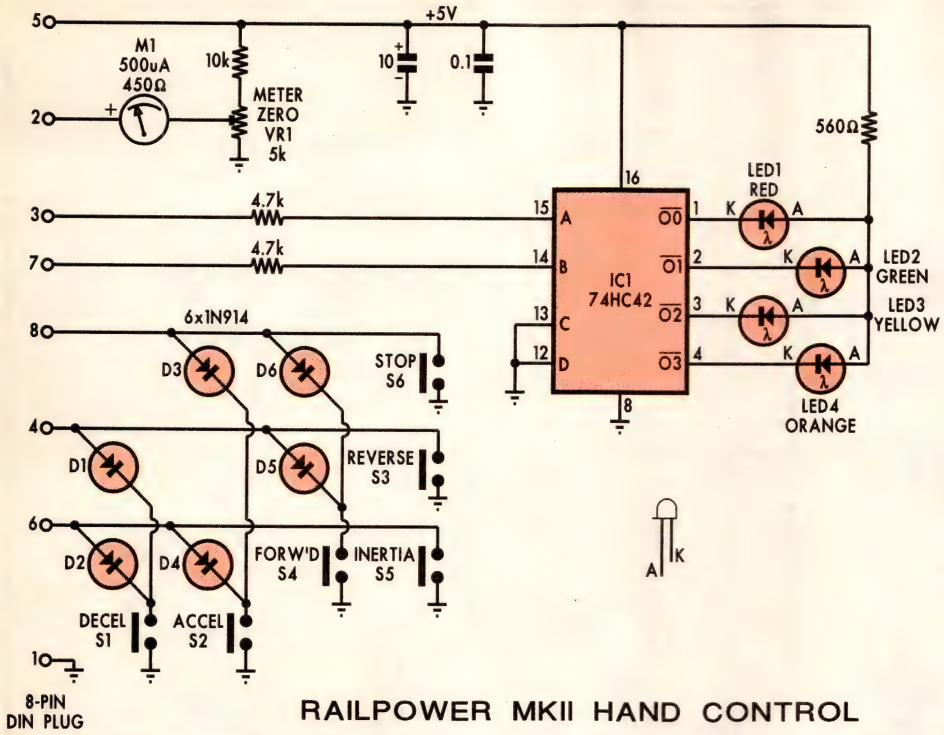


Fig.1: the hand controller circuit is based on IC1, a 74HC42 BCD decoder. This chip is used to indicate four modes of operation (via LEDs1-4) with only two lines from the microprocessor. The meter indicates both the track voltage and the selected speed setting when the faster or slower buttons are being pressed.

On the PC board, there are four trimpot adjustments: for maximum speed, minimum speed, inertia and brake. The maximum speed setting is usually set to give the maximum rated voltage for the particular locomotive. Typically, this is 12V DC for HO scale models but it can be lower for other scales such as N or Z. The minimum speed setting is determined by the quality of the locomotive's motor. Very good models may start to move with less than 1V across the track while others may need 4V or more before they start moving. By setting the minimum speed just below the point where the loco starts to move, more realistic and responsive operation is obtained.

The inertia setting controls the time the train takes to accelerate to maximum speed. This adjustment ranges from zero to four minutes. At the maximum setting, a loco may take more than one scale mile before it reaches its selected speed, just like a real train.

Inertia applies to deceleration as well as acceleration so a train will take approximately the same time to come to a stop as it took to reach its selected speed setting.

On the other hand, if you push the Stop button, the train will come to a halt much more quickly and the time it takes is set by the brake adjustment trimpot.

Low-cost microprocessor

The design brief for the Railpower MkII was that it had to be easier to build than the previous version, it had to have more features and it had to have all pushbutton operation. To achieve this, we have designed a completely new circuit which uses a low-cost microprocessor, the Zilog Z86E08. Now don't be scared off because the circuit uses a microprocessor. Have a read of the section headed "Micro-speak for modellers" and be reassured.

The Z86E08 (Z8, for short) comes in an 18-pin package and contains 2Kb bytes of OTP (one time programmable) memory. Two pins are for V+ and ground and two pins are for the crystal, while the remaining 14 pins are all available for control functions.

Using the processor allows us to carry out complex tasks which would otherwise require lots of conventional circuitry. The best example of this is the meter in the hand control. During normal running, it indicates the speed, from zero to 100%, at which the train is actually travelling. As the speed gradually increases (assuming that the inertia setting is large) the meter reading will increase to reflect this.

If the Faster or Slower button is pressed, the meter will momentarily indicate the previous selected speed setting and then move up or down to show the new setting. The new speed setting is only indicated while the buttons are actually being pressed.

Micro-speak for modellers

For many readers and railway modellers, this might be the first time you have come "face to face" with a microprocessor. Never fear, it's just a smarter IC than those you may have used before but otherwise it's just another black inscrutable chip.

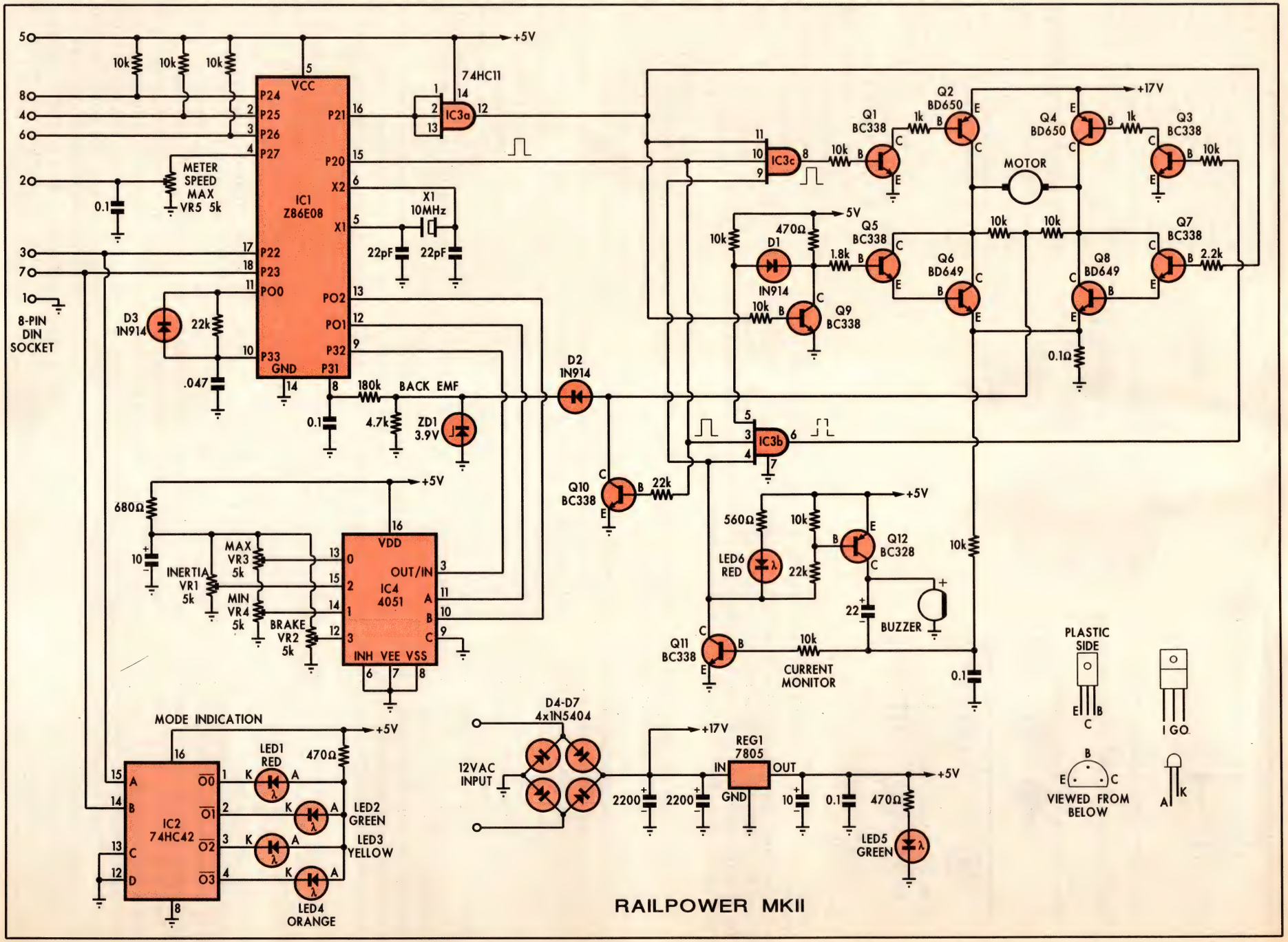
In essence, this Z8 micro is only a bunch of counters and gates, crammed into an 18-pin IC package. The big advantage is that we can control the logic in a manner which suits each particular application. While there are only a few leads to and from the processor, inside the chip we can have the equivalent of 50 or 60 gates and perhaps five counters interconnected. These might give an output on just one pin, should a certain sequence of events occur.

Just as we use standard ICs (hardware) and interconnect them to obtain the circuit functions we require, a similar design process is carried out when using a microprocessor. The difference in this case is that the design relies on a set of instructions (software) stored in the internal ROM (read only memory) of the micro.

Thus, each time we use the microprocessor in a different project, we store a different sequence of instructions in its ROM.

Before we go further, we should explain the pin descriptions for the microprocessor (IC1). It has three groups of pins, called ports in computer jargon. These are port 0, port 2 and port 3, abbreviated to P0, P2 and P3. P0 has three I/O pins (input/output), P2 has eight and P3 has three.

Thus, pin 15 which is labelled P20 is Port 2 line zero (computer people start counting from zero, not one like normal mortals). We have assigned this pin to be the one that turns the power to the track on and off. We did not have to use this pin; we could have used any pin on P2, or for that


+5V
74HC11
IC3a
IC3b
IC3c
VCC
IC1
Z86E08
P24
P25
P26
P27
P20
P21
P22
P23
P00
P01
P02
P31
P32
P33
GND
X1
X2
10MHz
22pF
22pF
METER SPEED MAX
VR5 5k
0.1
8-PIN DIN SOCKET
D3 1N914
22k
.047
180k
BACK EMF
4.7k
ZD1 3.9V
D2 1N914
680Ω
10
INERTIA VR1 5k
MAX VR3 5k
MIN VR4 5k
BRAKE VR2 5k
IC4 4051
VDD
OUT/IN
INH VEE VSS
MODE INDICATION
IC2 74HC42
LED1 RED
LED2 GREEN
LED3 YELLOW
LED4 ORANGE
470Ω
Q1 BC338
Q2 BD650
Q3 BC338
Q4 BD650
MOTOR
Q5 BC338
Q6 BD649
Q7 BC338
Q8 BD649
Q9 BC338
D1 IN914
1.8k
2.2k
1k
0.1Ω
Q10 BC338
22k
Q11 BC338
Q12 BC328
560Ω
LED6 RED
BUZZER
CURRENT MONITOR
D4-D7 4x1N5404
12VAC INPUT
2200
REG1 7805
IN
OUT
GND
LED5 GREEN
PLASTIC SIDE
E B C
VIEWED FROM BELOW
I GO
A K
RAILPOWER MKII

matter, P0. We could not use P3 as the pins on this port connect to two comparators, which are used to convert the analog voltages from preset potentiometers VR1-VR4 to digital values, which can be used by the processor. Enough on micros, let's get back to the main story.

Hand control circuit

The hand control consists of six pushbuttons, four LEDs, one IC (integrated circuit) and a few resistors, diodes and capacitors mounted on a small PC board measuring 74 x 50mm. The hand control connects to the Railpower via a 9-core cable (one unused) and an 8pin DIN plug. The circuit is shown in Fig.1.

Supply rails of 5V and 0V are fed via pins 5 and 1 on the DIN connector to IC1, a 74HC42 BCD (binary coded decimal) decoder. Four outputs from IC1 are used to drive the four LEDs. It was necessary to use the IC as there were insufficient outputs available on the microprocessor. By using the 74HC42, the microprocessor only needs two lines to control four LEDs.

Again, due to limited processor outputs and only eight pins on the connector, the six pushbuttons are accessed by three lines. We do this by using diodes D1-D6 which are connected in a simple matrix, allowing each button to pull one or two lines to 0V. As each line, or pair of lines, is connected to ground, it signals to the microprocessor the function required.

Main board

The main PC board contains four ICs, a 7805 regulator, 12 transistors, five trimpots and a handful of small components, mounted on a PC board measuring 143.5 x 108mm. The circuit is shown in Fig.2. Note the eight lines of the DIN socket. These connect to the hand control circuit of Fig.1.

The best way to explain the circuit is to go through the microprocessor start-up sequence. When power is first applied, the Z86E08 microprocessor executes a series of steps. First, it sets pin 15 low; ie, to 0V. This pin applies power to the track when it is high (+5V). Pin 16 is taken high to set the train direction to forward (low for reverse). Pins 17 and 18 are both taken low, which via IC2, another 74HC42 BCD decoder, illuminates the Stop LED. The same lines go to IC1 in the hand control to illuminate its Stop LED.

It then takes pins 12 and 13, which control the output of IC4, low. IC4, a 74C4051 8-input analog multiplexer, is simply a switch which can route any one of eight inputs to its output (pin 3). With pins 10 and 11 low, the wiper of the maximum speed trimpot, VR3, is connected via IC4's output to pin 9 of IC1. The microprocessor converts the voltage on the wiper to a digital value which it stores. Pins 12 and 13 of IC1 are taken high and low in sequence and the voltages from trimpots VR1, VR2 & VR4 are subsequently read and stored.

IC1 has now finished its "power on routine" and is ready to look at the hand control, to see if a button has been pressed.

H-bridge motor drive

Before we discuss this operation, let's look at the motor drive circuit which is known as an "H-bridge".

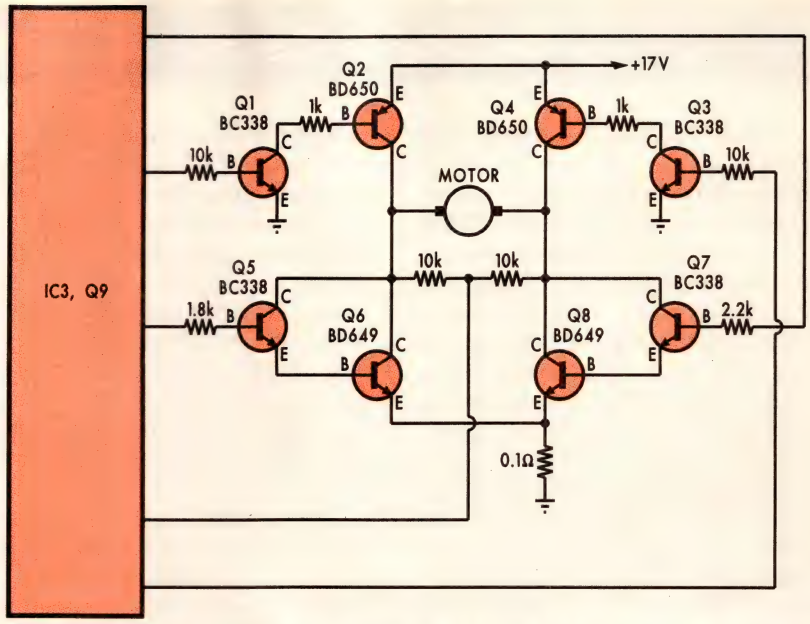


Fig.3: the H-bridge circuit. This controls the speed of the motor (depending on the pulse width), as well as its direction. For example, to make the motor go forward, Q8 is turned on continuously while Q2 is pulsed on and off. For reverse, Q6 is turned on continuously and Q4 is pulsed on and off.

This consists of four Darlington transistors – Q2, Q4, Q6 & Q8 – and these are driven by buffer transistors Q1, Q3, Q5 & Q7. To explain this part of the circuit better, we have reproduced it in Fig.3.

The H-bridge circuit does two things. First, it switches the power on and off to the motor. The rate of switching is 150Hz and the voltage fed to the motor is directly proportional to the width of the pulses. Second, the H-bridge allows the direction of the motor to be reversed, depending on which transistors are actually turned on.

In this case, to make the motor go forward, Q8 is turned on continuously while Q2 is pulsed on and off. Q4 & Q7 are turned off. To make the motor go in reverse, Q2 & Q8 are turned off, Q6 is turned on continuously and Q4 is pulsed on and off. Transistors Q1 & Q3 ensure that the Darlington transistors Q2 & Q4 turn on hard (ie, saturate) so that their power dissipation is minimal and small heatsinks can suffice. More impor-

Fig.2 (left): IC1, the microprocessor, controls all facets of circuit operation. As well as driving the H-bridge circuit (Q1-Q8), it reads the buttons in the hand control, the settings of the trimpots (VR1-VR4) via IC4, the back-EMF and the load current. As well, it drives the mode indicator (IC2) and the meter.

Myths & Magic of Pulse Power

Pulse power as used in the Railpower Mk I & MkII circuits is quite different to that used in some commercial train controllers. In the Railpower, the voltage is applied to the track in pulse form at 150Hz. At low speeds, the pulses are very short and high speeds, the pulses are much longer. This is very similar to the system used in switch-mode power supplies and is highly efficient. However, the reason we use this pulse power system is to get more reliable running. Because the peak voltage applied to the track is about 17 to 18V at all speed settings, it is much more effective at overcoming resistance due to dirty track, dirty motor brushes and commutators. The result is really good slow speed operation which means that your trains will look much more realistic. It's magic.

On the other hand, some modelling enthusiasts believe that pulse power can make motors run hot and can even burn them out. This is not true and there are a number of factors which ensure that pulse power does not damage model locomotive motors.

First, virtually all motors used in model locomotives are permanent magnet or series wound motors. In both types, the torque generated is proportional to the average current through the windings while the heating effect is proportional to the RMS value of the current. Now because we are using pulse power and the RMS voltage will be slightly higher than the average value, particularly at low speed settings, then it might be supposed that the motor's winding would get hotter than if pure DC was applied.

In practice though, two things come to the rescue. First, the motor's inductance tends to reduce the current drain when the speed settings are low, due to the very narrow applied pulses. Second, because the narrow pulses are actually much more effective in making the motor rotate and thus moving the locomotive forward, the motor then generates more back-EMF than it otherwise would with a low value of DC and thus the current is actually reduced. So in practice, the difference in motor dissipation between the unfiltered DC of most controllers and the pulsed DC of the Railpower is negligible.

The big danger of motors burning out is if the motor stalls due to a binding gear system. This risk applies to any model train controller, not just the Railpower.

Pulsed DC is also reputed to cause more motor noise than with pure DC. This tends to be true, partly because the Railpower allows the loco to run at a much lower speed than would be possible with unfiltered or pure DC across the track. At these much lower speeds, the motor noise is more significant; at higher speeds, the motor noise is drowned out by gear noise and wheel/rail noise.

Motor noise is also dependent on the quality of the gear systems and it can be amplified by locos of brass construction. Overall though, pulsed DC as used in the Railpower gives significantly better running, greater realism and more reliable operation.

However, coreless motors, such as those branded Portescap or Escap, should not be used with pulsed DC as they have very little inductance and generate very low back-EMF. These motors should only be used with pure DC train controllers. However, these motors are not generally used in model locomotives and so will rarely be encountered.

tantly, Q1 & Q3 perform voltage translation of the 5V logic signals to Q2 & Q4 which have a supply voltage of +17V. Q5 & Q7 ensure that their respective Darlingtons, Q6 & Q8, turn on fully.

Having described how the H-bridge works, we can now see how it is controlled by the micro, IC1.

As we stated previously, to select the forward direction, pin 16 of IC1 goes high, taking pins 1, 2 & 13 of AND gate IC3a high. IC3a is used simply as a non-inverting buffer, so its output at pin 12 is also high and thus Q7 & Q8 are turned on.

The output of IC3a also turns on Q9 which pulls its collector to 0V. This will turn Q5, and thus Q6, off. Pin 15 of IC1 is the pulse drive (150Hz) signal and this is fed via AND gate IC3c to turn on Q1 & Q2. Q9 also pulls pin 5 of IC3b low, via diode D1, and this means that output pin 6 will be low, turning off Q3 & Q4. To reverse the motor, pin 16 of IC1 goes low, so pin 12 of IC3a is low, turning off Q7, Q8 & Q9. This allows Q5 & Q6 to turn on and the pulse signal from pin 15 of IC1 passes via IC3b to Q3 & Q4.

Overload protection

Note that the emitters of Q6 & Q8 are connected via a common 0.1Ω resistor to the 0V line. This resistor is used to monitor the current supplied to the track. If there is a short circuit across the track, the voltage across this resistor will increase. This voltage is applied to transistor Q11.

If the voltage across the resistor rises above 0.6V, Q11 turns on, lighting LED 6 (overload indicator) and also turning on Q12, which drives the buzzer to give an audible indication of the short.

Not only do we get a visible and audible indication of the short but the system goes further and shuts down the voltage on the track, so that no damage can occur. This happens in the following way.

As pins 4 & 9 of IC3 are connected to Q11's collector, they will also be pulled low when Q11 turns on. This will turn off the power to the motor, whether it is running forwards or is in reverse. As there is now no voltage applied to it, there can be no current flow through the resistor and consequently Q11 will turn off. Power will be re-applied and the whole sequence will repeat until the short circuit is removed.

We have previously stated in the description that pin 15 of IC1 goes high to run the motor. Actually pin 15 goes high every 6.5 milliseconds, for a time dependent on the adjustment of

VR4, the minimum speed setting. If the operator presses the Faster button on the controller, the pulses from pin 15 are longer, effectively putting a higher voltage on the track.

Similarly if the Slower button is pressed, pin 15's pulse output will become shorter, reducing the average track voltage.

Speed regulator & back-EMF

As a model train comes to a gradient, it will tend to slow down, the speed reduction being dependent upon the motor's power and the slope. In severe situations, the train might even stop and this is not very realistic. Our circuit compensates for the extra load on the motor by increasing the voltage to the track so that the speed setting is maintained more or less constant. How is this done? By measuring the back-EMF of the motor and using it to control the micro, is the quick answer.

All electric motors generate a "back-EMF" which is the voltage which opposes current flow through the motor windings. If the motor speed is high, the back-EMF is high and current will be low. If the motor is stalled, the back-EMF will be close to zero and the current will be very high. So how do we measure the motor's back-EMF while it is running? It turns out that this pulse power system makes it fairly easy and we measure the back-EMF in the periods when the voltage applied to the track is zero; ie, between each pulse on pin 15.

We monitor the motor's back-EMF by means of the 10kΩ resistors connected to either side of the motor. While one side of the motor is always close to 0V (depending on whether Q6 or Q8 is off), the opposite side will always have the track voltage applied to it and thus one or other of the 10kΩ resistors will feed the voltage to the collector of Q10, then through D2 and the 180kΩ resistor to pin 8 of IC1. The capacitor on this pin filters this voltage.

Now the trick is to make sure that the voltage fed back to IC1 is the back-EMF and not the track voltage. This is done by turning on transistor Q10 via the pulse line, pin 15, of IC1. Thus, each time a pulse appears on the track, Q10 is turned on to short the anode of D2 to the 0V line.

Hence, the signal applied via D2 to pin 8 is a sample of the motor-back

PARTS LIST

HAND CONTROL

1 PC board, code 09109952, 74 x 50mm
1 plastic case, (Jaycar HB-6032 or equivalent)
1 8 pin DIN plug (Jaycar PP-0312 or equivalent)
1 500uA FSD edge reading meter (DSE Q-2110 or equivalent)
2 yellow PC mount momentary switches (Jaycar SP-0722 or equivalent)
1 red PC mount momentary switches (Jaycar SP-0720 or equivalent)
1 black PC mount momentary switch (Jaycar SP-0721 or equivalent)
1 white PC mount momentary switch (Jaycar SP-0723 or equivalent)
1 green PC mount momentary switch (Jaycar SP-0724 or equivalent)
1 5kΩ horizontal trimpot (VR1)

Semiconductors

1 74HC42 BCD decoder (IC1)
6 1N914 signal diodes (D1-D6)
1 3mm red LED (LED1)
1 3mm green LED (LED2)
1 3mm yellow LED (LED3)
1 3mm orange LED (LED4)

Capacitors

1 10µF 50VW electrolytic
1 0.1µF monolithic

Resistors (0.25W, 1%)

1 10kΩ 1 560Ω
2 4.7kΩ

Miscellaneous

1 cable clamp, Jaycar HP-0718 or equivalent
1 12mm x 2.5mm countersunk screw
1 2.5mm nut
2 #8 x 10mm self tapping screws
1 8mm untapped spacer
2 5mm untapped spacers

MAIN BOARD

1 PC board code 09109951, 143.5 x 108mm
1 plastic case, 140 x 110 x 35mm (Jaycar HB-5970 or equivalent)
1 8 pin chassis mounting DIN socket (Jaycar PS-0360 or equivalent)
1 10MHz crystal
1 PC board mounting buzzer (Jaycar HB-3458 or equivalent)
2 TO-220 heatsinks
5 5kΩ horizontal trimpots (VR1-VR5)
3 metres 9-way cable (Jaycar WB-1578 or equivalent)
4 PC stakes

Semiconductors

1 Z86E08 programmed OTP microprocessor (IC1)
1 74HC42 BCD decoder (IC2)
1 74HC11 triple AND gate (IC3)
1 74HC4051 or 4051B analog multiplexer (IC4)
1 7805 +5V regulator (REG1)
2 BD650 PNP Darlington transistors (Q2,Q4)
2 BD649 NPN Darlington transistors (Q6,Q8)
7 BC338 NPN transistors (Q1,Q3,Q5,Q7,Q9-Q11)
1 BC328 PNP transistor (Q12)
1 3.9V 500mW zener diode (ZD1)
3 1N914, 1N4148 signal diodes (D1-D3)
4 1N5404 rectifier diodes (D4-D7)
2 5mm red LEDs (LED1,6)
2 5mm green LEDs (LED2,5)
1 5mm yellow LED (LED3)
1 5mm orange LED (LED4)

Capacitors

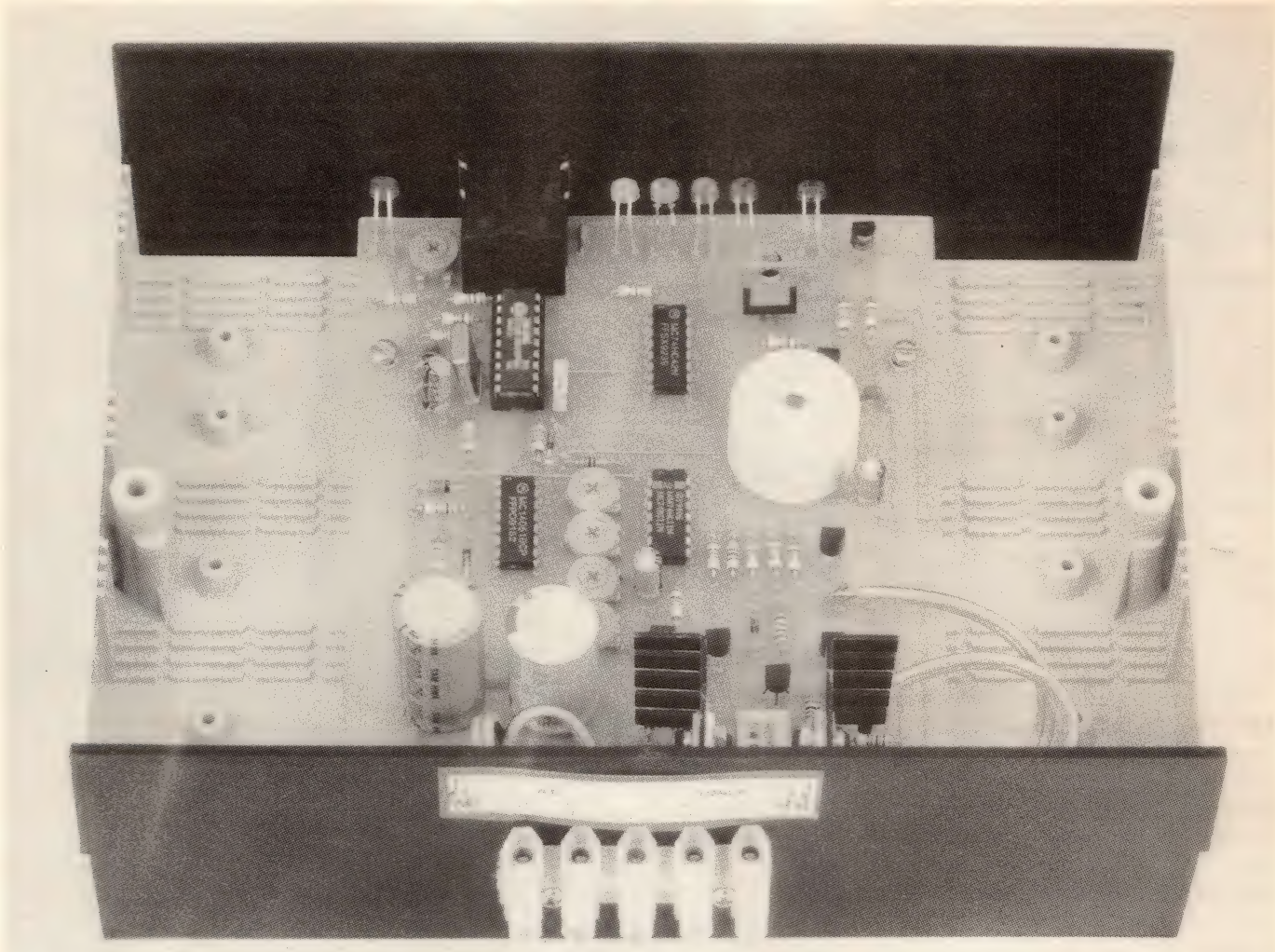
2 2200µF 25VW electrolytic
1 22µF 16VW electrolytic
2 10µF 50VW electrolytic
4 0.1µF monolithic
1 .047µF MKT polyester
2 22pF NPO ceramic

Resistors (0.25W, 1%)

1 180kΩ 2 1kΩ
3 22kΩ 1 680Ω
12 10kΩ 1 560Ω
1 4.7kΩ 3 470Ω
1 2.2kΩ 1 0.1Ω 5W
1 1.8kΩ

Miscellaneous

Solder, hook-up wire, plastic cable ties.



Although the circuit of the Railpower MkII is quite complicated, the PC board is relatively simple and has very little wiring.

EMF, not the track voltage. The voltage at pin 8 is filtered by the 0.1µF capacitor, so that commutator hash does not give false readings.

This voltage at pin 8 is compared with the desired setting and if the value starts to drop, due to the train slowing or the load increasing, the microprocessor increases the track voltage, to keep the loco running at a constant speed.

Maximum speed setting

Previously, we discussed VR3, the maximum speed adjustment, and described how it is used to set the maximum track voltage, to suit the locomotives being used. We also discussed the meter which has two modes, one to indicate the actual track voltage and the other, to indicate the track voltage being set by the Faster and Slower buttons.

The meter is driven directly from pin 4 of the microprocessor, via trimpot VR5.

During the setup procedure, trimpot VR3 is used to set the maximum track voltage and then VR5 is used to set the meter's pointer to full scale, to give a 100% reading. In the same procedure, trimpot VR4 is used to set the minimum track voltage and trimpot VR1, in the hand control, is used to set the meter to zero.

In practice, it will be necessary to do the adjustments for the various trimpots more than once, before they are correct.

A 10MHz crystal is used by the microprocessor and is connected between pins 6 & 7, along with two 22pF capacitors to ensure the crystal oscillates reliably.

Power supply

No power transformer is included in the circuit as it is assumed that modelling enthusiasts will already have a suitable controller power supply or a 12V battery charger. As presented, the circuit can deliver peak currents of about 6A, which corresponds to a maximum output of about 4A continuous. A 12V charger rated for at least 4A or a 12V power transformer with a rating of 60VA is recommended.

Unfiltered DC from the external 12V battery charger or AC from an external 12V power transformer is applied to a bridge rectifier consisting of diodes D4-D7. These rectify the input and their output is filtered with two 2200µF capacitors to give unregulated DC of about +17V and this is the motor supply, applied to the emitters of Q2 & Q3. The +17V rail is also applied to the 7805 5V regulator which supplies all the other circuitry in the Railpower.

Next month, we will complete the description of the Railpower MkII, giving all the construction details and setting up procedure. **SC**

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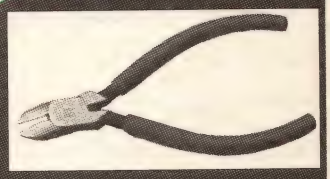

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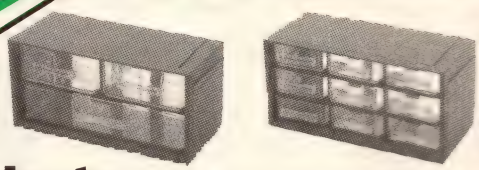

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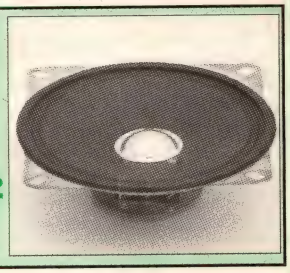

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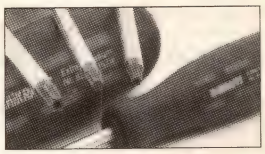

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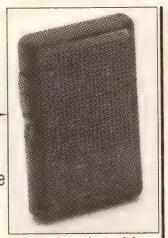

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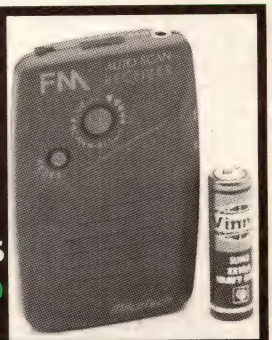

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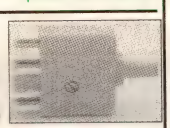

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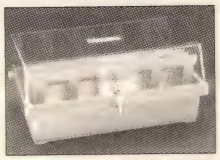

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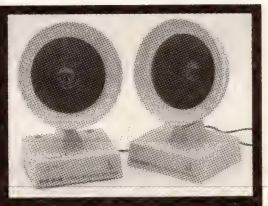

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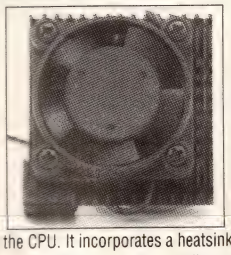

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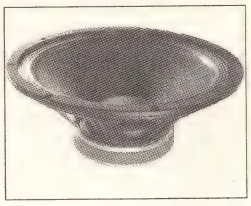

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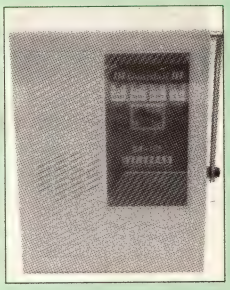

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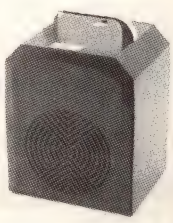

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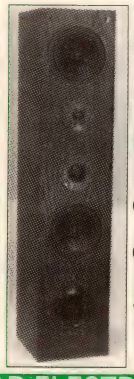
CS2430	Bookshelf / Dolby Rear Spkr - Pair	299.00	200.00
CS2432	Centre Dolby Speaker	269.00	180.00
CX2632	Car Crossover 3 Way 150HZ / 10K	49.95	25.00
DC3090	CB Mic Clip - Self Adhesive	2.95	1.50
DC3092	2 Pin CB Power Lead	5.95	2.50
HP0463	4mm Hex Nut - Packet 200	5.95	2.95
HP0645	Bolt 6 x 16mm Silver Packet 12	2.95	1.00
HP0646	Bolt 6 x 16mm Black Packet 12	2.95	1.00
HP1151	T03 Rubber Washer Packet 100	25.95	16.95
HM3216	5 Way Launcher Right Angle	0.60	0.20
HB5020	Eddystone Die Cast Box Bargain	9.95	5.00
HB5120	1 Unit PRO RACK CASE	75.00	59.00
HB5125	2 Unit PRO RACK CASE	99.50	79.50
HB5130	3 Unit PRO RACK CASE	109.50	89.50
HB5420	44mm Black Non Conform Panel	4.00	2.00
HB5421	44mm Silver Non Conform Panel	4.00	2.00
HB5423	88mm Silver Non Conform Panel	7.00	3.50
HB5468	Metal Box 305 x 150 x 200	34.95	24.95
HB5503	Size 4 Multipurpose Box	5.50	3.00
HB5570	Bench End 132x278x304,Cat.P120	59.95	39.95
HB6090	Small Desk Console	12.95	8.95
HB6094	Large Desk Console	22.95	16.95
HB6315	Quick Kit Component Case	17.95	12.95
HK7024	24mm Brushed Alum Knob	2.85	1.25
HP9560	PCB - Open Spaced Grid, Cat.P128	3.95	2.50
HH8543	8 FNF Diecast Heatsink	13.95	10.00
KJ6770	4 In 1 Solar Construction Kit	24.95	17.95
LF1241	Toroid Core 20 x 13 x 6	6.50	2.00
LF1242	Toroid Core 17 X 745 X 22	15.50	10.00
LT3028	75Ω Wall Plate Socket	5.00	2.00
LA5011	Door Announcer	18.95	12.95
MF1006	PCB T/F 9 + 9V 7VA	13.50	9.50
MF1012	PCB T/F 15 + 15V 7VA	13.50	9.50
MP3029	20VAC 2A Power Supply	15.00	10.00
MP3112	Novatel Battery Eliminator	39.50	5.00
MB3501	Solar Charger 2 x C / Sub C	16.95	12.00
MB3508	12V 450mA SLA battery Charger	22.50	15.00
MS4000	IEC In Line Mains Filter	20.00	15.00
MS4002	2 Outlet Squeeky Mains Filter	99.50	69.50
MS4025	Squeeky Mains Filter - 2 Outlets	149.50	110.00
MI5060	Inverter 24V to 240V 1000W	649.00	599.00
PS0360	8 PIN DIN Socket - Right Angle PCB	1.00	0.30
PP0394	Red Banana Plug - Quality	1.20	0.60
PP0395	Black Banana Plug - Quality	1.20	0.60
PP0418	2mm TIP DMM Plug Red	1.65	0.50
PP0420	2mm TIP DMM Plug Black	1.65	0.50
PP0653	BNC Plug - Rapid Solderless	2.95	1.50
PP0654	BNC Plug - Right Angle	3.20	1.50
PS0661	BNC Scart - Right Angle	3.20	0.80
PP0684	PL259 Reducer	0.75	0.20
PP0835	D23 Plug	2.95	1.00
PM0837	D23 Backshell	2.20	0.80
PM0839	D25 Economy Hood - Packet 10	10.00	4.00
PP0859	D Sub Data Port Speed Conn.	5.00	1.00
PP0891	R/A 50 Pin Centronic Plug	2.95	1.50
PM0898	Wallplate 2 x D25 Stainless	3.50	2.00
PS0899	R/A 50 Pin Centronics Socket	3.95	2.00
PS0908	D15M to RJ12 Socket Adaptor	4.95	2.00
PP0920	Disk Drive Plug - 4 Pin	2.75	1.50
PP2032	2 Pin Wired Plug and Socket	3.95	2.00
PI6555	24 Pin DIL IDC Header Plug	2.95	1.50
PI6558	40 Pin DIL IDC Header Plug	3.50	1.50
PI6560	34 Way IDC Suit Disk Drive	2.95	1.50
PB8830	Mini Breadboard Dist Strip	5.95	1.00
PH9225	4 - AA Nicad Battery Stacker	0.50	0.20
QP5070	Edge Meter - VU Black / Red	3.95	1.50
QP5072	Edge Meter - S Signal Strength	3.95	1.50
RN3410	RDE050 Polyswitch	6.95	2.95
RN3418	RDE24A Polyswitch	10.95	3.95
RP3812	200Ω Multiturn Pot	7.95	4.95
RP3814	500Ω Multiturn Pot	7.95	4.95
RP3826	50K Multiturn Pot	7.95	4.95
RP3830	100K Multiturn Pot	7.95	4.95
RP3900	Assoted Linear Pot Pack	10.00	6.00
RP3901	Assorted Log Pot Pack	10.00	6.00
RP3977	33Ω 3W Wire Wound Pot	4.95	2.95
RP3980	100Ω 1W Wire Wound Pot	4.95	2.95
RP3988	3.3K 3W Wire Wound Pot	4.95	2.95
RG5195	Mkt Polyester Cap Pack 75	10.00	6.00
RC5500	2UF 440V Modem Capacitor	5.95	2.00
BE6242	3300uf 63v RB Electro	4.95	2.95
RE6247	10000uf 25v RB Electro	6.95	3.95
RU6742	1000uf 35v RG Can Electro	2.00	1.00
RU6743	1000uf 63v RG Can Electro	2.75	1.50
RU6744	1000uf 100v RG Can Electro	3.50	1.95
RU6745	2200uf 25v RG Can Electro	3.00	1.50
RU6750	4700uf 25v RG Can Electro	4.50	2.00
RU6773	3300uf 63v LY Electro	4.50	2.00
RU6780	15000uf 16 LY Electro	5.95	2.00
SS0820	Mini SPST Slide SW	0.60	0.20
SK0950	DPDT 240v 15A Black Rocker	4.50	2.00
SK0951	SPDT C/Off 250v 5A Rocker	2.50	0.50
SK0953	SPDT C/Off 250v 5A Rocker	2.50	0.50
SK0954	SPDT 240v 15A Rocker	3.50	1.00
SK0955	DPST 240v Illuminated Rocker	4.95	2.00
SK0960	SPST 240v 10A Rocker	1.00	0.20
SK0999	Swann Rocker Switch Pack	12.95	8.95
SM1025	10 Way DIL Switch	3.00	2.00
SM1026	12 Way DIl Switch	3.50	2.50
SM1029	CAM Lock	6.95	4.95
SR1280	240v Rotary On/Off Switch	2.95	1.50
SZ2023	3AG Fuseclip - Packet 100	12.95	6.95
SZ2050	Fuse puller	2.25	1.00
SF2150	125MA M205 Fuse	0.35	0.10
SF2169	200MA M205 Slow Blow Fuse	1.40	0.30
SF2214	35AMP 3AG Fuse	0.35	0.10
SL2626	240v Orange Round Bezel	1.20	0.50
SL2637	Car Alarm Globe - Flange	4.50	1.50
SL2638	Car Alarm Globe - Thin	5.50	1.50
TS1461	1mm Solder Iron Tip - Old TS1461	9.95	5.00
TS1462	1.5mm Solder Iron Tip - Old TS1461	9.95	5.00
TS1610	Sponge for OK Station	3.95	2.50
TS1708	Hot Sol Hot Air Tip	9.95	5.00
TS1710	Hot Sol Flame Torch Tip	3.95	2.00
WA1007	5 DIN to 5 DIN Lead 3 Metre	5.95	2.95
WB1506	Hi Quality Single Shielded Audio	2.00	0.80
WB1507	Hi Quality Fig.8 Shielded Audio	3.95	1.60
WB1602	4 Cone Phone Cable - Flat	0.50	0.30
WB1603	6 Cone Phone Cable - Flat	0.65	0.40
WH3018	Pink 13/.12 Hook Up	0.30	0.10
WH3020	HUW6 Hook UP Wire Packet 5	10.95	6.95
WH3022	HUW7 Hook UP Wire Packet 5	6.95	4.95
WW4336	W/Wrap Wire 5.5" Red Packet 100	5.95	2.50
XB2100	Plastic Swivel Base	9.95	6.95
XC4792	5.25" Head Clean Kit	4.95	3.95
XC5072	3 Way Data Switch Centronics	39.95	20.00
XC5075	2 Way Data Switch D25	19.95	10.00
XC5153	Monitor CPU Stand	39.95	29.95
YX2507	60mm Fan Guard	2.95	1.50
ZR1036	6A 1000v Stud Diode	2.50	1.00
ZV1605	LM309K +5v 1.5A T03	5.95	3.95
ZT2325	2N3643 Transistor	0.80	0.30
ZT2449	2SJ49 Mosfet (P0)	14.95	10.00
ZT2450	2SJ56 Mosfet (N)	22.95	15.00
ZT2454	2SK134 Mosfet (N)	10.95	6.95
ZL3334	LM334Z Current Source	2.95	1.50
ZL3572	NE572 Stereo Compander	9.95	5.00
ZC4012	4012 Dual Input Nand Gate	1.00	0.50
ZC4076	4076 Quad D Flip Flop	1.20	0.50
ZC4502	4502 Strobed Hex Inverter	1.95	0.50
ZZ8000	Z80A CPU 4mhz	6.95	3.95
ZZ8208	9368	9.50	1.00
ZZ8460	2732 Eprom	11.95	5.00
ZZ8473	27512 Eprom	14.95	7.95
ZK8860	DAC0800	4.75	2.50
ZK8880	TMS 3477NL Voice IC	12.95	8.95
ZR9500	PIR Sensor	12.95	5.00

DUKE SPEAKER GIVEAWAY

SAVE $150

DK11 Speaker Kit

6" bass and dome tweeter. 4 ohm impedance, suitable for home and car Hi Fi. See 95 cat page 47.



SPEAKER KIT WITH BUILT CABINETS - 11 ONLY

Cat. CS-2520/22 Cat price $399pr Birthday $249pr

SAVE $100

SPEAKER KIT ONLY - 38 ONLY

Cat. CS-2520

Catalogue price $229pr Birthday $129pr

SAVE $160

STEREO AUDIO MIXER SALE

See catalogue page 82 for full details.

7 Input / 3 Output Cat. AM-4212 Was $159

Birthday Price $129 Save $30

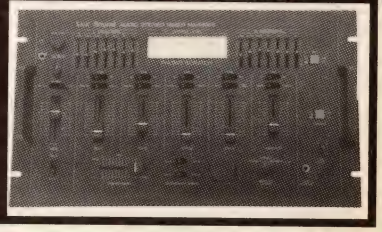
Digital Echo / Equaliser 7 Input / 3 Output

Cat. AM-4214 Was $239

Birthday Price $200 Save $39

Professional

AM4216 Pictured



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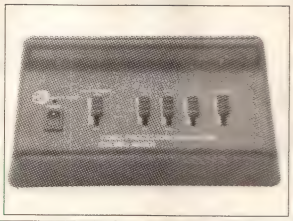
Video Processor With Enhancer & Stereo Mixer

This is the old model as shown in our 94 catalogue page 68. Make home recordings from your camcorder. Requires 12VDC 100mA adaptor for power cat MP-3002 $10.95.

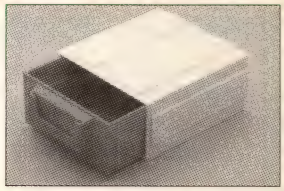


Cat. AV-6410 **94 Price $79.95**

Birthday Price $49.95

Save $30

Interlocking Parts Drawer



Single drawer unit. Locks together with others top and side.

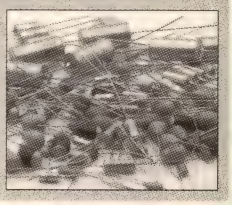
Cat. HB-6300

Cat Price $5.95

Birthday Price $3.95 Save $2

Tantalum Capacitor Pack

See cat page 98. Approx 100 caps in Tag and RT style.



Cat. RZ-6690

Cat Price $15

Birthday Price $10

Save $5.00

Ultra Mini Micro Switch

Momentary SP action in either P/on or P/off. 19(L) x 7(W) x 8(H)mm.

Cat. SM-1037

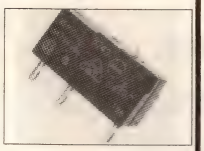
Cat Price $1.95

Birthday Price 50¢

Save $1.45

Mini Micro Switch

Momentary SP action in either P/on or P/off. 20(L) x 6(W) x 11(H)mm.



Cat. SM-1038

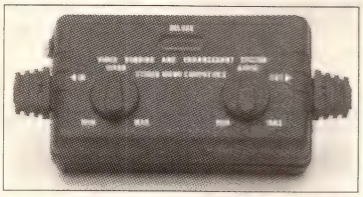
Cat Price $2.75

Birthday Price $1

Save $1.75

Super Booster Video Enhancer

Prevents loss when dubbing from one video to another. See cat page 85. Cat. AV-6500



Cat Price $39.95

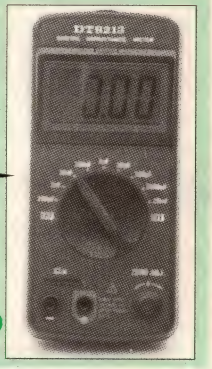
Birthday Price $25.00 Save $14.95

Jaytech Digital Capacitance Meter

BRAND NEW MODEL!!! Has a unique tilting LCD display which allows you to read at any angle. General specs:

NEW

•Display - 3.5 digit LCD •Range - 9 ranges 200pf to 20mf •Sampling time - 0.5 seconds •Accuracy - 0.5% ranges 200pf to 200mf ranges, 1.0% range 2,000uf, 2.0% range 20mf.



Cat. QM-1572 **$99.50**

Easy Ear

Personal Hearing Amp System.
Sits in your top pocket. Supplied with earphone. See cat page 185.

Cat. AA-2040

Cat Price $19.95

B'day Price $9.95

Save $10.00

14 Band SW/AM/FM Mini Radio

Features 3.1 to 17.6mHz. See cat p 184.

Cat. AR-2200

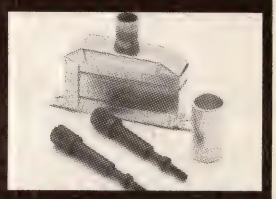
Cat Price $42.95

B'day Price $29.95

Save $13.00

D25 Shielded Hood Bargain!!!

Contek Brand.
Supplied with thumbscrews.



Cat. PM-0838

Normally Around $3.95

Birthday Price $1.50

Save $2.45

K-Type Temp Thermocouple For DMM's

Measure external temps on DMM's. Supplied with metal probe.

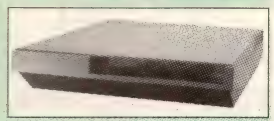
Cat. QM-1282

Cat Price $12.95

Birthday Price $9.95 Save $3

Bargain Computer Case

See July ads for full details. Size 360(D) x 340(W) x 70(H)mm. Mail order customers add extra $4 due to weight.



Cat. HB-5100

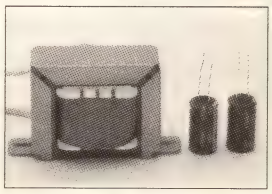
Was $20

Birthday Price $10

Save $10.00

50 Amp Car Noise Suppressor Kit

Includes choke and 2 capacitors.
See cat page 67.



Cat. AA-3078

Cat Price $28.95

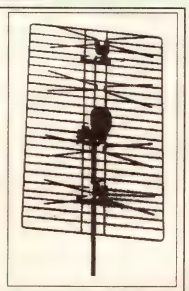
Birthday Price $18.95

SAVE

Save $10

UHF Phased Erray Antenna

Excellent for poor performance areas.
See cat page 96.



Cat. LT-3185

Cat Price $69.95

B'day Price $55

Save $14.95

360° Ceiling Mount Pulse Count PIR

NEW

Attractive slimline design giving 11 metre radius at 3.6m ceiling height - much easier to mount in certain situations, and cables can be easily run through house ceilings instead of down walls. •Operating voltage: 8 to 16VDC •Current draw: 15mA •Output: NC contacts •Tamper: NC •Pulse count: 1 or 2 selectable.

DONT PAY $69.95

Cat. LA-5020 **only $49.95**

FREECALL FOR PHONE ORDERS 008 022 888

BUY 10 LESS 10%

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METAL ENCLOSURE BARGAINS

Prices reduced further. See July ads for full details.

CABINET NO 1

Size: 165(W) x 175(H) x 360(D)mm. Powder coated and unpainted units available.

Powdercoated **Cat. HB-6510** **Was $35** **Birthday Price $25**

Nataural **Cat. HB-6515** **Was $25** **Birthday Price $15**

CABINET NO 2

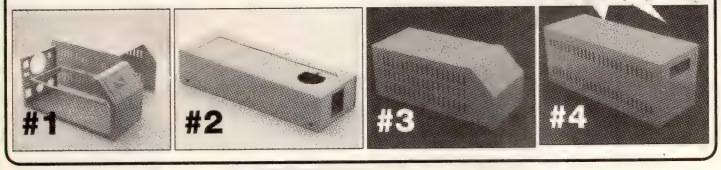
Size: 78(W) x 46(H) x 210(D)mm.

Powdercoated **Cat. HB-6520** **Was $10** **Birthday Price $7.50**

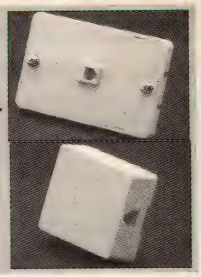
CABINET NO 3

Similar to cabinet No 1 but a bit smaller. Size: 162(W) x 145(H) x 355(D)mm. Powdercoated **Cat. HB-5625** **$22.50**

NEW LOWER PRICES



Modular Telephone Sockets



Two types available. Both are NOT Austel approved. 4 wire connectors - colour fawn.

LARGE SIZE: Measures 120 x 76mm

Cat. YT-6057 **only 50¢ea**

SMALL SIZE: Usual skirting board type. Entry on end. Measures 55 x 49mm

LA Acoustic Car Alarms

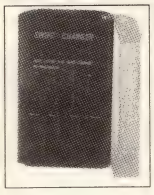
Features: •Remote control •complete protection •engine kill •not secure warning •remote lock/unlock •emergency panic system •double protection •auto door locking •alarm memory. See 1995 catalogue page 80.

Cat. LA-8901

Was $169 **B'day Price $139** **Save $30**

SAVE $3

9V AA/AAA NiCad Charger



See catalogue page 112

Cat. MB-3512

RJ45 Wall Socket

This unit is a standard power point size plate with 2 x RJ45 8/8 sockets mounted. They have sliding covers. Input cable connection is IDC. Austel approved # A90/831/0181.

MINI ENGRAVER

Runs on 12VDC. See cat page 93 for full details.

Cat. TD-2480

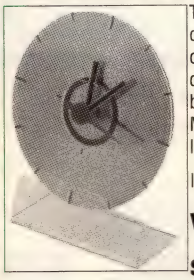
Cat Price $17.95

Ultrasonic Transducers

These units operate at 39kHz. Suitable for Burglar Alarms, Movement Detectors and Interrupted Beam. They are sold as a transmit and receive pair. See cat page 76 for details. **Cat. AU-3850**

Cat Price $14.95 Save $7

CD DESK CLOCK



This clock features a compact disk mounted on a perspex stand. Ideal for desks, mantle pieces, bedrooms, on top of the TV etc. Modern decor suits our modern living. Runs on 1 x AA battery.

Ideal gift. **Cat. XC-0110**

Was $16.95 Save $6.95 **B'day**

JAYCAR WHOLESALE

(02) 743-5222

Toroidal Transformer Bargains

35 + 35V 160VA Cat. MT-2116

Was $49.95 **Birthday Price $**

SAVE $$$

NEW 128K DATABANKS

128K DATABANK:

Features: •telephone databank •business card library •real time clock •calendar •calculator •currency •memo •schedule •world time •computer interface avail - extra (see cat for details - see 64K unit p183).

Cat. QM-7325 **$149**

NEW

128K DATABANK WITH 6 LANGUAGE TRANSLATOR:

All the features of the above unit plus: •6 language translator - English, French, German, Italian, Spanish and Dutch •5,940 useful phrases are classified into 13 categories - greetings, air travel/customs, hotel, resaurant, sight seeing, shopping, communications, medical /emergency, financial, transportation/directions, entertainment, sports /leisure, beauty/hygiene. Total words approx 42,000 (inc sentences).

Cat. QM-7330 **$179**

PC INTERFACE FOR BOTH - OR TO OTHER UNITS:

Cat. QM-7324 (Also suits 64K unit) **$39.50**

OTHER DATABANKS:

64K	Cat. QM-7320	**$129.50**	8K	Cat. QM-7305	**$27.95**
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Don't know what a Leatherman is? This pocket multitool when folded looks like a pocket knife. Simply open it up, and fold the unit back on itself to reveal a pair of pliers. There is also some typical pocket knife attachments, which include: •large knife •small knife •bottle opener •slot screwdriver •Philips head screwdriver •can opener •file. Supplied in a black case with belt clip for easy carrying. Folded size: 100(L)x30x20mm. Cat. TH-1900

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These are a 2nd brand for famous name car speakers. Look at the name on the surround ring. Consists of a 6.5" woofer and a Neodidyium Super Tweeter and a high power crossover. They handle high power so need a high power amplifier. They sound excellent and we can't understand why they won't sell. At this months birthday price they represent an absolute bargain. See cat page 64. Specs: •Power handling: 80WRMS,

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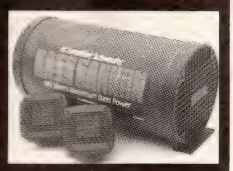
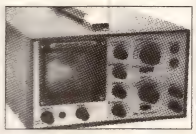


8" subwoofer with amplifier built in and 2

Storm Subwoofer Tube Sellout

See 94 catalogue p46. 8" subwoofer, •100WRMS handling •Freq: 60-3kHz •Effeciency: 88dB 1W/1m. VERY LIMITED QTY.

6.4mHz CRO Sellout



See 95 catalogue page 36.

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Height when opened 120mm. See catalogue page 85.

Cat. AV-6532

Cat Price $22.95

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BB-7405	Intro 68000 assem language	182	8.75	5.95
BB-7406	Intro to MSDOS	180	8.75	5.95
BB-7408	Intro to Supercalc 5	181	13.95	8.95
BB-7410	Intro to Lotus 123	182	11.50	7.50
BB-7411	Lotus 123 release 3.4	182	16.95	11.95
BB-7412	Lotus 123 release 2.4	182	13.95	7.95
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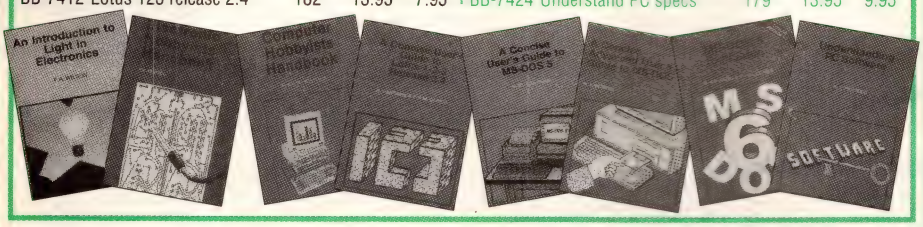
BB-7423	Understand PC software	179	13.95	8.95
BB-7424	Understand PC specs	179	13.95	9.95



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Includes •RCA to RCA video lead •2 RCA to 2 RCA audio lead •2 x 5 pin plug to 2 RCA sockets •2 x adaptors RCA socket to 3.5 mini plug •2 x adaptors RCA skt to PL259 plug •2 adaptors RCA skt to BNC plug

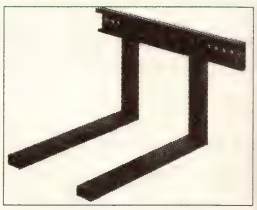
Cat. AV-6538 **Cat price $19.95**

Birthday $12.95

SCART KIT

Includes •6 Din to 6 Din lead •2 x Din skt to 3 RCA plug lead •Din skt to 8 pin mini video plug lead •2 x 5 Din to 2 RCA skt lead •RCA skt to BNC plug adaptor •2 x Scart plug to 6 Din skt adaptor

Speaker/Microwave Wall Bracket



Ideal for speakers, clothes dryers, TVs etc. Shelf has adjustable depth 375-570mm. Wall bracket length is 420mm. Max load capacity 31kg.

Cat. CW-2820

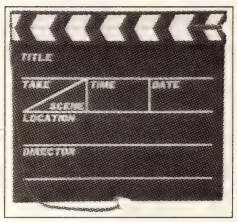
Video Transfer System

Transfer films, slides and photos to video. See 95 cat page 83.

Cat. AV-6540

Cat Price $129.50

Directors Clapper Board

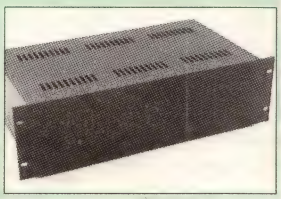


You see these all the time in commercial movie making. See cat page 83.

Cat. AV-6530

Catalogue

Save On 3 Unit Rack Cabinets



See our 1995 catalaogue page 121.

132mm Black **Cat. HB-5414**

132mm Silver **Cat. HB-5415**

NEW IC'S

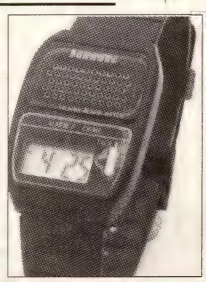
LM3886T 50 watt Audio Amp

As used in twin 50 watt amp from Silicon Chip. Output: 48w/8Ω, 60w/4Ω Freq: 16hz-200kHz THD: <.05%

Cat. ZL-3757 **$21.95**

M65830P Delay IC

Jaycar ELECTRONICS Birthday TALKING WATCH



The Talking Watch will say the time at the push of a button. Ideal for anyone with impaired sight, or for using in dark places, or for fun for the kids. The watch will say the time every hour if required and it has an alarm. Don't pay $29.95

Cat. XC-0240 **Cat price $19.95** **B'day Price**

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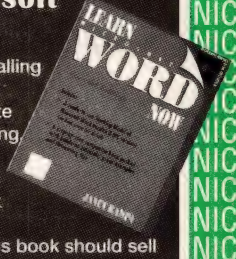

Includes info on installing your working model, then gives a complete guided tour of entering, editing, formatting text, saving files and printing. Includes 1 x 1.2mB 5.25" disk for IBM, PC/XT, 386. This book should sell for $65. 399 pages Softcover

235x185mm **Cat.: BM-2142**

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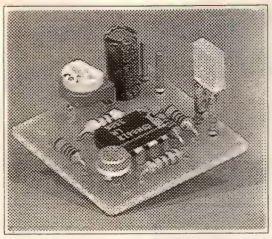
NEW KIT
LED Battery Voltage Indicator Kit



REF: ELEC AUST 9/95
This tiny project measures just 25 x 25mm and can be used in just about any piece of battery operated equipment to combine the functions of a power-on LED and battery voltage indicator. Suitable for 6-30 volts. Kit includes PCB and all electronic components including bi-colour LED.

Cat. KA-1778 **$9.95**

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SIMPLE TO USE
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Catalogue Price $699 B'day Price $599
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Cat Price $79.50
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Cat. HB-5504

Only $3.95 ea

Laminator

Keep photos and business cards forever by laminating them. See cat page 190 for full details.
Cat. XL-2500

Cat Price $79.95
Birthday Price $59.95
Save $20 Laminating sleeves available.

Business Card Sleeves - Pkt 100 Cat. XL-2504 **Only $9.95**

Low Cost Temperature Controlled Soldering Iron

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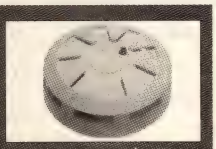
It has a PTC (Positive Temperature Coefficient) soldering tip at a constant temperature of 310°C which is ideal for PC work. It has a 20 second heatup time. Replacement Tip Cat TS1202 $9.95

Cat. TS-1200 1994 Price $49.95
Birthday Price $29.95 Save $20

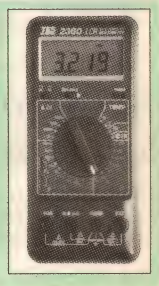
Smoke Detectors



Be safe, battery operated. See cat page 75.
Cat. LA-5090

Cat Price $12.95
B'day Price $9.95 **Save $3**

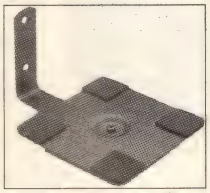
SAVE $40 ON DMM WITH INDUCTANCE



•3.75 digit •4000 Count •39 Range •Inductance •Capacitance •Frequency •Temperature •Peak Hold •Logic
See 1995 catalogue - Page 28 for full details.
Cat. QM-1475

Cat Price $189
B'day Price $149 Save $40

Low Cost Speaker Brackets



Will accept speakers up to 200mm deep and 10kgs in weight. See cat page 53.
Cat. CW-2835

Cat Price $19.95pr
B'day Price $12.95pr **Save $7**

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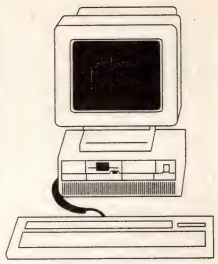
COMPUTER BITS

BY GREG SWAIN



Running MemMaker & avoiding memory conflicts

Having trouble with General Protection Faults in Windows? Try running the MemMaker memory optimisation program. This will sometimes overcome the problem and your programs will run more efficiently too.

I remember seeing a movie some time ago – a Western actually – in which someone gets shot. "Who would want to shoot Bad Bart?", queried a bystander after the bullets had stopped flying and everyone had crawled out from behind the bar. "Just about everyone who ever knew him", came the reply.

What's this got to computers and memory? Well, in this case, the question is "Who's encountered a General Protection Fault when running Windows?" Answer: "just about everyone who's ever used it".

OK, so it's a bad analogy but you get the general idea – General Protection Faults in Windows are not uncommon. There you are working away happily, running lots of applications, when all of sudden up comes an error message. Often, it will read something like this: Progman caused a General Protection Fault in module Filename at 0001:0296.

Now isn't that helpful? What this means in plain English is that your Windows application has written to a memory space that was already occupied, clobbering another module (or file) in the process. As a result, the system becomes unstable and the wisest course is usually to exit all applications and reboot Windows.

Now there are lots of reasons why GP faults can occur, including incompatible terminate-and-stay-resident programs (TSRs) or device drivers in your CONFIG.SYS and AUTOEXEC.BAT files. In that case, you can often troubleshoot the problem by removing these TSRs – just type "REM: in front of the appropriate entries.

If that solves the problem, you can then proceed to replace the lines one by one until the problem reappears. When it does, you'll know which one is causing the GP fault.

Often, however, GP faults are caused by other memory management problems. If you consistently get the same error message when a certain function is performed, then running MemMaker may overcome (or at least minimise) the problem.

Computer memory

Before we take a look at the MemMaker program, let's first briefly look at how memory is organised in a PC.

Fig.1 shows the memory configuration of a typical computer. The first 640Kb is called "conventional" memory and is used by all MS-DOS programs. Above that but below 1Mb is a 384Kb block called the "upper memory area". This block is normally reserved for use by hardware expansion cards, such as your display adapter, and for shadowing video ROM and the ROM BIOS.

Following the upper memory area, the area beyond 1Mb is known as "extended" memory. This memory requires the use of an extended memory manager such as HIMEM.SYS and this device driver is typically loaded as the first line in your CONFIG.SYS file.

Finally, the first 64Kb of extended memory is known as the "high

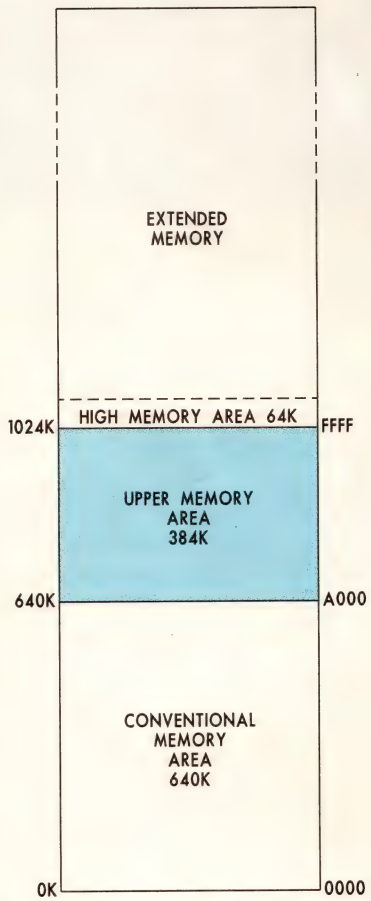
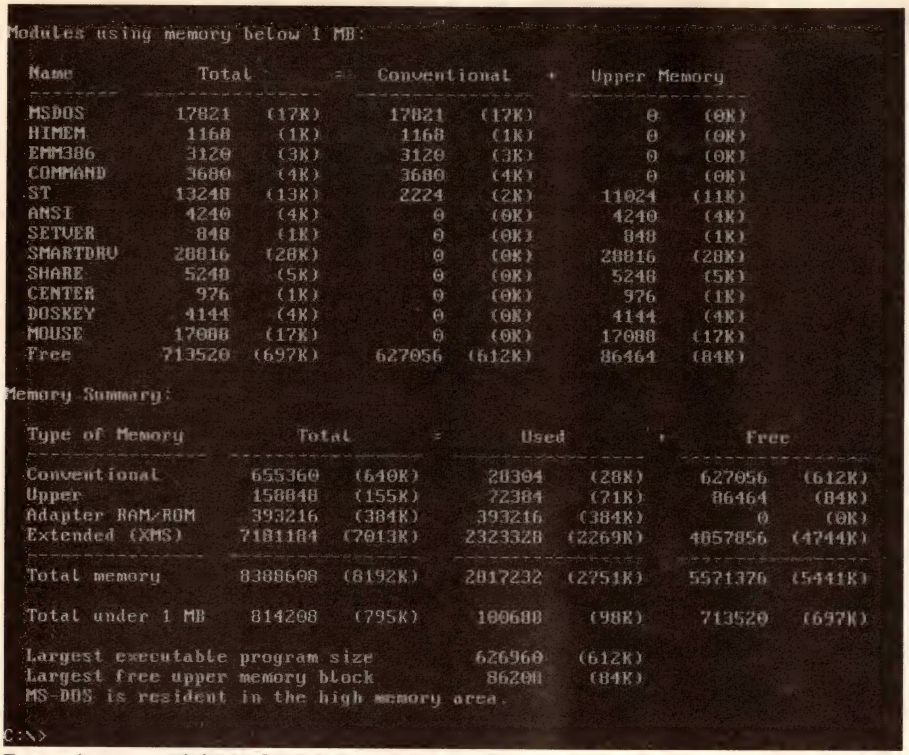


Fig.1: the memory configuration in a PC. The first 640Kb is called "conventional" memory, while the area from 640Kb to 1024Kb (1Mb) is the "upper memory area". The area beyond 1Mb is known as "extended" memory.



```
Modules using memory below 1 MB:

  Name           Total            Conventional        Upper Memory
  --------  ---------------   ---------------   ---------------
  MSDOS      17821   (17K)      17821   (17K)         0    (0K)
  HIMEM       1168    (1K)       1168    (1K)         0    (0K)
  EMM386      3120    (3K)       3120    (3K)         0    (0K)
  COMMAND     3680    (4K)       3680    (4K)         0    (0K)
  ST         13248   (13K)       2224    (2K)     11024   (11K)
  ANSI        4240    (4K)          0    (0K)      4240    (4K)
  SETVER       848    (1K)          0    (0K)       848    (1K)
  SMARTDRV   28816   (28K)          0    (0K)     28816   (28K)
  SHARE       5248    (5K)          0    (0K)      5248    (5K)
  CENTER       976    (1K)          0    (0K)       976    (1K)
  DOSKEY      4144    (4K)          0    (0K)      4144    (4K)
  MOUSE      17088   (17K)          0    (0K)     17088   (17K)
  Free      713520  (697K)     627056  (612K)     86464   (84K)

Memory Summary:

  Type of Memory        Total              Used              Free
  ----------------  ---------------   ---------------   ---------------
  Conventional       655360   (640K)     28304   (28K)    627056   (612K)
  Upper              158848   (155K)     72384   (71K)     86464    (84K)
  Adapter RAM/ROM    393216   (384K)    393216   (384K)        0     (0K)
  Extended (XMS)    7181184  (7013K)   2323328  (2269K)   4857856  (4744K)
  ----------------  ---------------   ---------------   ---------------
  Total memory      8388608  (8192K)   2817232  (2751K)   5571376  (5441K)

  Total under 1 MB   814208   (795K)    100688    (98K)    713520   (697K)

  Largest executable program size          626960   (612K)
  Largest free upper memory block           86208    (84K)
  MS-DOS is resident in the high memory area.

C:\>
```

By typing mem /c/p at the DOS prompt, you can see which programs are loaded into conventional memory and which are loaded into upper memory. It will also tell you how much free conventional memory you have and whether or not MS-DOS is resident in the high memory area.

memory area" (HMA). Usually, MS-DOS is set to run in the HMA, to free up conventional memory for use by other programs.

To see how your computer currently organises memory, exit Windows and type **mem /c/p** at the DOS prompt. This will show you which programs are loaded into conventional memory and which are loaded into upper memory. It does this by displaying a detailed listing of the load order and size of these programs – see Fig.2.

It will also tell you how much free memory you have, the largest executable program size and whether or not MS-DOS is resident in the high memory area.

What MemMaker does

Because the hardware expansion cards do not use up the entire upper memory area, it contains free areas of space and these are known as "upper memory blocks" (UMBs). When you run MemMaker, it modifies your AUTOEXEC.BAT and CONFIG.SYS files so that some TSRs and device drivers are loaded into these UMBs instead of into conventional memory.

As a result, conventional memory is freed and this can make a big difference to the way your programs run. If you've already run MemMaker and subsequently installed additional software, it can also help to avoid memory management conflicts be reallocating space in the upper memory blocks.

By the way, in order to load programs into the upper memory blocks, you must use an expanded memory manager such as EMM386.EXE. Depending on the entry in your CONFIG.SYS file, this device driver can also use extended memory to simulate expanded memory for those DOS-based programs that require it.

Typically, the first three lines of CONFIG.SYS will look like this:

```
DEVICE=C:\DOS\HIMEM.SYS
DEVICE=C:\DOS\EMM386.EXE NOEMS
DOS=HIGH,UMB
```

Note that it is necessary to load HIMEM.SYS before EMM386.EXE to gain access to the upper memory blocks. The NOEMS switch ensures that EMM386.EXE behaves as an upper memory manager only and prevents it from allocating extended memory (EMS) for use as expanded memory (XMS). Use this switch if your programs do not require expanded memory, as this frees an additional 64Kb of upper memory for running device drivers and programs.

On the other hand, if you run a DOS-based program that does require expanded memory, you will have to replace the NOEMS switch with the RAM switch instead. This will allow EMM386.EXE to simulate expanded memory so that the program will run. For example, the command:

```
DEVICE=C:\DOS\EMM386.EXE 512 RAM
```

will allocate 512Kb of your computer's extended memory for use as expanded memory. Note that you should only allocate as much expanded memory as the program requires and this will usually be specified in the installation manual.

If the command line that loads EMM386.EXE is missing, it can easily be added by editing the CONFIG.SYS file in an ASCII text editor. Alternatively, the MemMaker program will automatically install and configure EMM386.EXE for you.

Start-up disc

Before running MemMaker, it's vital that you create a start-up disc in case anything goes wrong. To do this, install an unformatted floppy disc in drive A and type: FORMAT A:/S. This done, copy your AUTOEXEC.BAT and CONFIG.SYS files (and preferably your SYSTEM.INI file in the Windows directory) to the floppy disc.

That way, if anything goes wrong, you can boot from the start up disc and simply copy the original files over the top of the modified files on the hard disc.

It's also a good idea to disable any commands in your AUTOEXEC.BAT and CONFIG.SYS files that start unnecessary device drivers and utility programs. This will help to free up conventional memory by ensuring that such programs do not compete for space in upper memory. For example, if you only use a mouse when running Windows, then you can disable any mouse device drivers such as MOUSE.COM.

To disable a command, simply open the file in an ASCII text editor (eg, DOS Edit or Notepad) and insert a REM statement at the beginning of the command line, eg:

```
REM DEVICE =C:\DOS\MOUSE.
```

This done, save the file and then

reboot the computer. By disabling the command in this manner, rather than deleting the line, you can easily restore it later on if required.

Running MemMaker

MemMaker is supplied with MS-DOS 6.0 and above and is straightforward to run – just quit all programs, go to the command prompt (ie, C:>) and type **Memmaker**. All you have to do then is follow the on-screen prompts or the step-by-step procedure set out in the manual.

Unless you are an experienced user, it's best to choose Express Setup (as opposed to Custom Setup) when running MemMaker for the first time. You should also initially answer "No" to the prompt that asks you whether you use any programs that require expanded memory, unless you are sure that the reverse is true.

If you choose No and subsequently find that some programs no longer run or display error messages (eg, "Expanded Memory Unavailable"), then its simply a matter of running MemMaker again and answering "Yes" to the same question.

After you have finished running MemMaker, take a look at your CONFIG.SYS and AUTOEXEC.BAT files. In CONFIG.SYS, you will see that MemMaker has changed certain "device" commands to "devicehigh" and added switches to those "devicehigh" commands. Similarly, in AUTOEXEC.BAT, you will find that MemMaker has added "lh" (loadhigh) to the beginning certain commands.

These "devicehigh" and "lh" commands ensure that the corresponding device drivers and TSRs are loaded into the upper memory area. Note, however, that HIMEM.SYS and EMM386.EXE cannot be loaded high.

Now for the acid test – to find out what effect MemMaker has had on your system, go to the command prompt and again type **mem /c/p**. You should see that many (if not all) of the available device drivers and TSRs are now loaded into upper memory instead of conventional memory. In addition, you should have a corresponding increase in conventional memory.

Fig.3 shows a typical AUTOEXEC.BAT file before and after running MemMaker, while Fig.4 shows typical before and after CONFIG.SYS files.

If you encounter problems after running MemMaker, you can easily undo the changes that have been made. To do this, you simply go to the command prompt (ie, C:\>) and type: **Memmaker /undo**. By then following the on-screen prompts, the program will restore the original AUTOEXEC.BAT, CONFIG.SYS and SYSTEM.INI files, using backups that it made dur-

AUTOEXEC.BAT

Before MemMaker

```
@ECHO OFF
VERIFY OFF
PATH C:\DOS;C:\WINDOWS;C:\ALDUS;C:\PM5;C:\UTIL;
    C:\DESKSCAN;C:\TSCSI;
SET TEMP=C:\TEMP
SET DIRCMD=/P/O
PROMPT $P$G
C:\DOS\MOUSE
C:\DOS\MSCDEX.EXE /D:PANASON /L:R
C:\DOS\DOSKEY
VER
WIN
```

After MemMaker

```
@ECHO OFF
VERIFY OFF
PATH C:\DOS;C:\WINDOWS;C:\ALDUS;C:\PM5;C:\UTIL;
    C:\DESKSCAN;C:\TSCSI;
SET TEMP=C:\TEMP
SET DIRCMD=/P/O
PROMPT $P$G
LH /L:3,56928 C:\DOS\MOUSE
LH /L:3,27984 C:\DOS\MSCDEX.EXE /D:PANASON /L:R
LH /L:2,6400 C:\DOS\DOSKEY
VER
WIN
```

Fig.3 (above): a typical AUTOEXEC.BAT file before and after running MemMaker. MemMaker has added "LH" commands to the start of several lines, to ensure that these TSRs are loaded into the upper memory blocks.

CONFIG.SYS

Before MemMaker

```
DEVICE=C:\DOS\HIMEM.SYS
DEVICE=C:\DOS\EMM386.EXE NOEMS X=C800-CBFF
BUFFERS=30,0
FILES=60
DOS=HIGH,UMB
LASTDRIVE=Z
FCBS=4,0
DEVICE=C:\TSCSI\MA348.SYS
DEVICE=C:\TSCSI\TSCSI.SYS
DEVICE=C:\CDMKE.SYS /D:PANASON
DEVICE=C:\DOS\SETVER.EXE
DEVICE=C:\DESKSCAN\SJII.SYS
BREAK=ON
COUNTRY=61,,C:\DOS\COUNTRY.SYS
SHELL=C:\DOS\COMMAND.COM C:\DOS\ /E:1024 /p
STACKS=9,256
```

After MemMaker

```
DEVICE=C:\DOS\HIMEM.SYS
DEVICE=C:\DOS\EMM386.EXE NOEMS X=C800-CBFF
BUFFERS=30,0
FILES=60
DOS=HIGH,UMB
LASTDRIVE=Z
FCBS=4,0
DEVICEHIGH /L:2,9568 =C:\TSCSI\MA348.SYS
DEVICEHIGH /L:2,15488 =C:\TSCSI\TSCSI.SYS
DEVICEHIGH /L:2,13472 =C:\CDMKE.SYS /D:PANASON
DEVICEHIGH /L:2,12048 =C:\DOS\SETVER.EXE
DEVICEHIGH /L:1,7040 =C:\DESKSCAN\SJII.SYS
BREAK=ON
COUNTRY=61,,C:\DOS\COUNTRY.SYS
SHELL=C:\DOS\COMMAND.COM C:\DOS\ /E:1024 /p
STACKS=9,256
```

Fig.4 (right): devices are loaded into the upper memory blocks using the DEVICEHIGH command. Note, however, that HIMEM.SYS and EMM386.EXE cannot be loaded high.

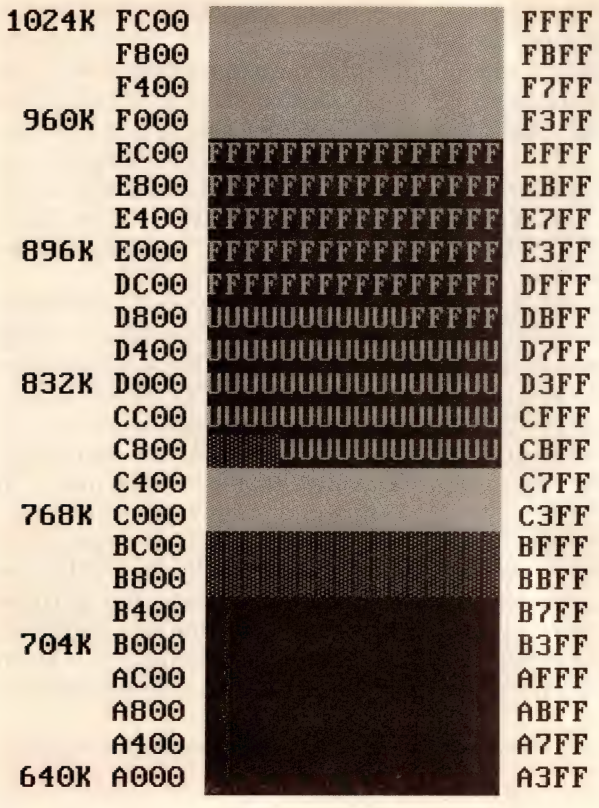


Fig.6: this detailed map shows the upper memory area from A000-FFFF. The gray areas are treated as ROM and are reserved for the video card (C000-C7FF) and the ROM BIOS (F000-FFFF). The areas marked with "U" indicated used UMBs, while "F" indicates free UMBs.

ing the optimisation process.

Alternatively, if you suspect that the problem might be caused by one or more commands in AUTOEXEC.BAT or CONFIG.SYS, you can bypas some or all of the commands in these files (MS-DOS 6.0 and above).

To bypass all the commands in these two files, press the F5 key when you see the text "Starting MS-DOS . . ." while the computer is booting up. Alternatively, to bypass individual commands, press the F8 key instead and follow the on-screen prompts to carry out or bypass each command in turn.

The Memmaker.sts file

That's not necessarily the end of the memory optimisation process. Often, you can free up even more memory by changing the order of the command lines in your CONFIG.SYS and AUTOEXEC.BAT files.

The reason for this is that as each driver is loaded in turn into the upper memory area, it uses the largest free remaining UMB. This means that if the smaller drivers are loaded first, the remaining UMBs might not be able to accommodate some of the larger drivers.

In this case, these remaining large device drivers will be loaded into conventional memory rather than upper memory, despite the presence of "devicehigh" or "lh" commands.

The trick is to reorganise your CONFIG.SYS and AUTOEXEC.BAT files so that the largest device drivers are loaded first. That way, it will be easier to fit the remaining drivers into the smaller UMBs that are left over.

How do you know the sizes of your device drivers? Well, when you run MemMaker for the first time, it logs this information in a file called MEMMAKER.STS (in the C:\DOS directory). Open this file in an ASCII text editor (or better still print it out) and make a note of the MaxSize line for each command in the [SizeData] section – see Fig.5.

It's now simply a matter of editing the CONFIG.SYS and AUTOEXEC.BAT files so that those command lines with larger MaxFile values are positioned above those with smaller MaxFile values (make sure that HIMEM.SYS and EMM386.EXE are before any of these, however). Save each file in turn, then reboot your computer to check that the system starts properly and that there are no error messages during start-up. If all is well, run MemMaker again to optimise the system for the revised CONFIG.SYS and AUTOEXEC.BAT files.

```
Command=C:\DOS\SETVER.EXE
Line=11
FinalSize=864
MaxSize=12048
FinalUpperSizes=0
MaxUpperSizes=0
ProgramType=DEVICE
```

Fig.5: a typical section from a MEMMAKER.STS file. The MaxSize value is the one to note.

By now typing **mem /c/p** at the command prompt again, you can quickly check how much more conventional memory has been freed.

Note, however, that the above procedure is not always hassle free. Sometimes, for example, it is necessary to load the drivers for a particular device in a set order (where more than one driver is involved). If the order is incorrect, you will get an error message during boot-up, often to the effect that a particular driver is missing. In that case, it's usually just a matter of moving the command line for the "missing" driver ahead of its companion driver.

Fig.4 shows an example of this. If you look at this file, you will see that the line

```
DEVICEHIGH /L:2,9568 =C:\TSCSI\MA348.SYS
```

precedes the line

```
DEVICEHIGH /L:2,15488 =C:\TSCSI\TSCSI.SYS
```

even though the second line has the largest MaxSize value. That's because it's necessary to load MA348.SYS before TSCSI.SYS for this particular device (an external cartridge drive).

Fine tuning

Now take a look at the detailed memory map of Fig.6. One important thing to realise here is that not all addresses in the upper memory area are available for loading device drivers and TSRs. For example, the area from A000-C800 is reserved as ROM for video card addresses, while the area from F000-FFFF is reserved for shadowing the ROM BIOS. Similarly, the area from E000-EFFF is also normally a reserved area.

What this means is that these ranges are out of bounds for use as UMBs unless you specifically instruct EMM386.EXE to include certain areas within them (ie, EMM386.EXE does not map over unused ROM). This is done using the **I=** switch.

For example, if your computer has a VGA or EGA monitor, you can generally include the range of address from B000-B7FF and from E000-EFFF. In this case, the EMM386 entry in your CONFIG.SYS file would look something like this:

```
DEVICE=C:\DOS\EMM386.EXE I=E000-EFFF
                         I=B000-B7FF NOEMS
```

If you subsequently find that your monitor doesn't respond correctly or your computer hangs when you start Windows, delete the I=B000-B7FF entry. If you still have problems, delete the I=E000-EFFF statement

On the other hand, it is also often necessary to specifically exclude certain address ranges to prevent memory conflicts with hardware cards. If this is not done, a device driver can be loaded into the address normally occupied by the hardware card and this will prevent the card from being found.

For example, let's say that you have a hardware card (eg, a scanner card) at address C800. In this case, you might want to exclude the range from C800-CBFF and this is done using the **X=** switch, ie:

```
DEVICE=C:\DOS\EMM386.EXE I=E000-EFFF
                         I=B000-B7FF NOEMS X=C800-CBFF
```

Note that MemMaker will normally automatically exclude the address ranges occupied by hardware cards the first time you run it. If you subsequently install another hardware card and you strike problems, try changing the address setting on the card. Alternatively, you can work through the section entitled "You Installed A Hardware Device And Your Computer Stopped Working" in chapter 8 of the MS-DOS 6 manual.

By the way, it's also a good idea to edit the **Emmexclude=** entry in SYSTEM.INI, to prevent Windows from accessing this address range when running in Enhanced mode – ie, add the line **Emmexclude=C800-CBFF** to the [386Enh] section of SYSTEM.INI.

In addition, some video cards use additional memory in the region from C400-C700. Although Windows automatically detects most of these cards and avoids this area, there are cases where you have to specifically exclude it using the **Emmexclude** entry. For example, to avoid the area from C400-C7FF (to prevent conflict with a video card) and from C800-CBFF to prevent conflict with another hardware card, the line would read: **Emmexclude=C400-CBFF**.

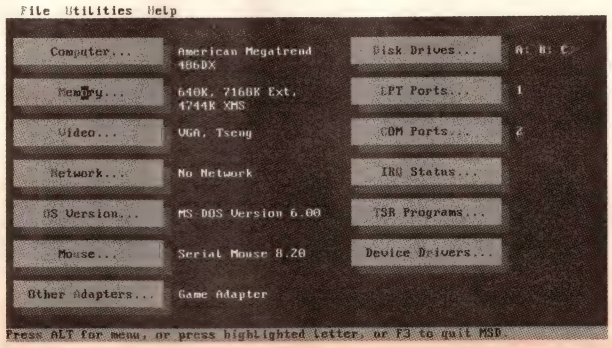
If you are still having trouble running Windows in enhanced mode (eg if the system frequently crashes), try starting Windows using the "/d:x" switch – ie, type **win /d:x** at the command prompt. This will prevent Windows from accessing any of the upper memory area and is equivalent to adding **Emmexclude=A000-EFFF** to SYSTEM.INI.

If this solves the problem it means that there is a conflict with some hardware card that Windows is unable to detect. To solve this problem, you need to identify which hardware card is causing the problem and then exclude its address with Emmexclude. To find out the address, check the address switches on the card or use the Microsoft Diagnostics program MSD.EXE .

Try to limit the excluded the range to the specific card. If Windows is unable to find enough free UMBs for what are called "translation buffers" when it loads, it uses conventional memory instead. As a result, there will be less memory available to run non-Windows applications.

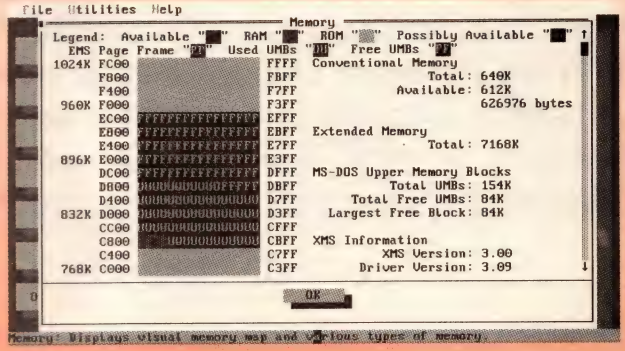
Finally, if it's all too hard, consider upgrading to Windows 95. With this system, the old DOS/Windows combination is gone and you don't have to worry about tweaking AUTOEXEC.BAT, CONFIG.SYS and SYSTEM.INI files. Is your computer up to Windows 95? Here we go again! **SC**

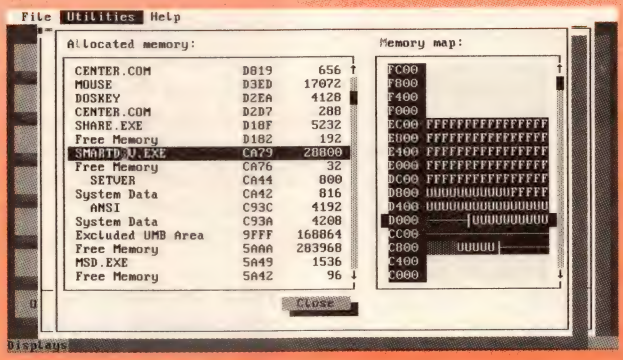
Exploring the Memory with MSD



1. To see how memory is allocated in your machine, go to the DOS prompt and type MSD. The screen shown at left will appear. Click on Memory.

2. The resulting screen shows free (F) and used (U) UMBs, plus areas which are reserved as ROM. Click the down arrow to see the area below C000.





3. Clicking "Utilities" and then "Memory Block Display" brings up this screen. You can now examine the memory allocated to each driver by clicking on it (in this case, SMARTDRV.EXE).

Further Notes On The Train Detector For Model Railways

As soon as the June 1995 issue appeared on the streets, we received very favourable feedback to the Train Detector circuit. But as often happens, one reader wanted to use it in a way we had not envisaged. In this short article, we feature his problem and describe how to solve it.

By LEO SIMPSON

The reader's problem is as follows and sets out an application where the block switching covered in the June 1995 article is not required. This application envisages the Train Detector being used in a one-off situation.

Reader's letter

I am keen to build the Train Detector featured in the June 1995 issue and wish to use it with the Sound & Lights for Level Crossings, as featured in the April 1994 issue. My problem is that I don't want to use the block switching system you describe for the Train Detector. I just want to use it to detect the train moving into the section which has the level crossing.

I also don't want to run wires all the way back to my train controller (Infrared Remote Control, April & May 1992) because I have a large layout and I want to minimise the amount of extra wiring required. Therefore, instead of wiring back to the controller I just want to wire the Track Detector directly off the track where the level crossing is going to be. Now, if that doesn't sound too confusing, how do I go about it? Finally, can I use the same power supply to run the Sound & Lights circuit as for the Train Detector? (K. A., Mona Vale, NSW).

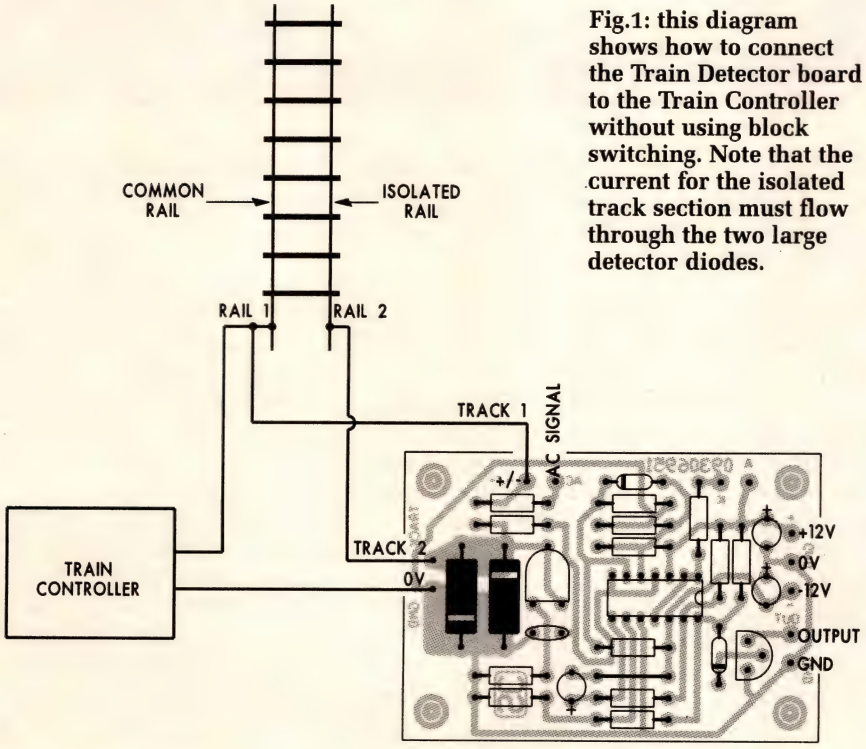


Fig.1: this diagram shows how to connect the Train Detector board to the Train Controller without using block switching. Note that the current for the isolated track section must flow through the two large detector diodes.

How it's done

It's amazing, isn't it? No matter how much thought we put into the presentation of these projects, someone always writes in to ask how to do something else that we hadn't thought of doing. As it happens, this proposal does not present any real problems.

First, you do need a section of the track to be isolated from the rest of the layout. One rail can be common to the rest of the layout and one section of rail must be isolated, as shown in the diagram of Fig.1. This shows one side of the controller wired to the common rail (rail 1) while the other side of the train controller goes to the 0V terminal on the Train Detector PC board. The rail 1 connection also connects to the track 1 terminal on the PC board (labelled "+/-" on the copper side of the board). The isolated rail (rail 2) goes to the track 2 terminal on the PC board, adjacent to the 0V terminal.

Fig.1 shows how the train controller is connected to the isolated section of track but the reader wants to wire the Train Detector directly to the track, without wiring back to the controller. OK, Fig.2 shows how to do it. This shows a track with an isolated section. As before, the common rail is rail 1 while the isolated rail is rail 2. The corresponding rail connections

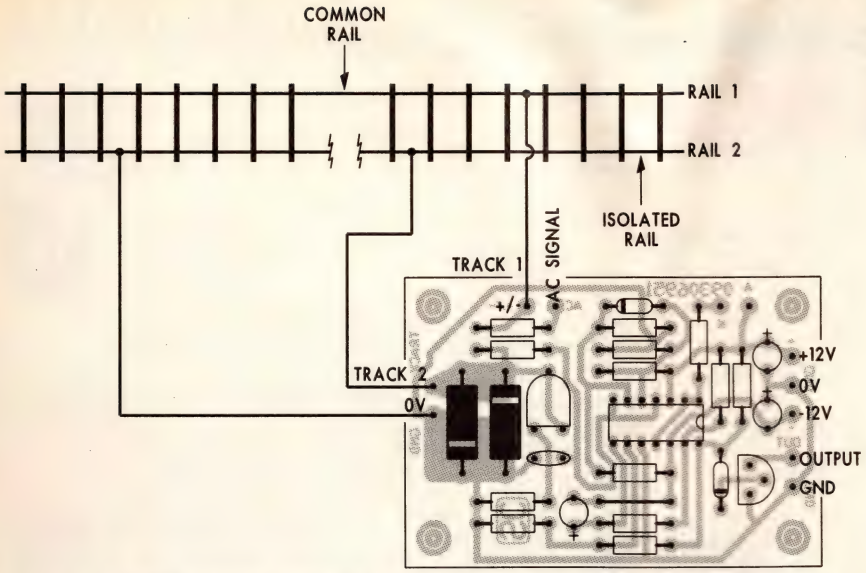


Fig.2: this diagram shows how the Train Detector can be wired to an isolated section of track without the need for any connections to the Train Controller itself. Note that, as before, the current for the isolated track section must flow through the two detector diodes.

to the Train Detector are the same as in Fig.1. Note that the DC and AC connections from the power supply to the Train Detector must still be as shown in Fig.3 on page 29 of the June 1995 issue.

One small point to note with this proposal is that the voltage applied from the train controller to the isolated track section will be lower by 0.6V than the voltage supplied to the rest of the track. This is a consequence of the voltage drop across the current detector diodes, D1 & D2. This will lead to a small drop in speed as the loco enters the isolated track section and a slight pick-up in speed as the loco leaves the section but this is unlikely to lead to problems and may actually give an increase in realism.

As far as the idea of using the Train Detector power supply for the Sound & Lights circuit is concerned, remember that the Train Detector has +12V, 0V & -12V supply lines while the Sound & Lights circuit needs only +12V and 0V lines. In that case, all you need do is to connect the +12V and 0V lines from the Train Detector power supply to the Sound & Lights board. The output line from the Train Connector goes to the input of the Sound & Lights board.

There is no need to connect the GND terminal on the Train Detector to the GND terminal on the Sound & Lights board since the circuit will be completed via the 0V connections. Do not make any connection from the -12V line to the Sound & Lights board.

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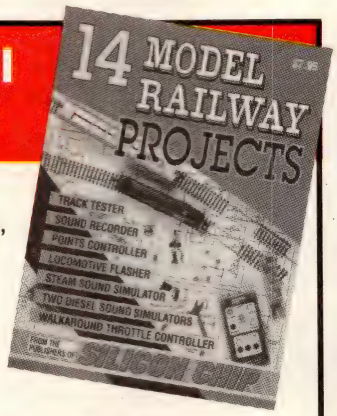

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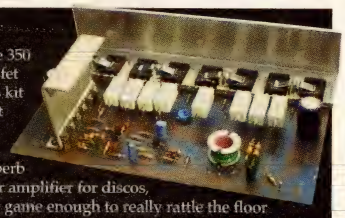

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(See SC July/Aug '88) The Discolite flashes party lights on and off in beat with music from your amplifier. **Features:** • 4 light channels controlled by 4 separate audio channels • Forward reverse and auto-reversing chaser patterns • Simultaneous strobe on all four channels • Alternating light patterns • Music modulation available on chaser strobe and alternate patterns • Inbuilt microphone or direct inputs for beat triggering or audio modulation of lights • Sensitivity control • Individually pre-settable sensitivity levels for each channel • Front panel LEDs mimic light display • Altronics Kit pre-punched and silk screened

K 5805 **$159.50**

40 Volt 3 Amp Variable Power Supply Kit

(See SC Jan/Feb '94) This 1.23 V to 40 V adjustable power supply is designed for heavy-duty work. It uses a high efficiency switching regulator circuit. Features preset voltage and current limiting, full overload protection (with indicators) and an LCD panel meter for precise voltage and current readouts.

K 3330 **$239.95**

Multi-Station Headset Intercom Kit

Calling All Muso's & Theatre Production People!

(See SC June '92) This multi-station headset intercom is designed to provide clear communication in high noise environments such as at race tracks and rock concerts. It is designed to operate with a headphone and mic combination. Each headset requires a station module. Stations are simply connected in a daisy-chain fashion. Up to 12 units (stations) can operate from one power supply. Features low noise circuitry and compares favourably to commercial equivalents. Mics can be switched on continuously (even at the one time) for hands free operation of all stations. Also includes visual and audio call function. Ideally suited to our C 9055 headset mic and the C 9070 noise attenuating Aviation Headset.

K 5250 Station Module **$74.95**

K 5255 Power Supply **$64.95**

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OVERNIGHT DELIVERY

True RMS Digital Multimeter

Supplied with high quality hard carry case and silicon test leads. This 3.75 digit 4000 count digital multimeter would have to be one of the best meters we have seen. Features include menu driven functions (no complicated instructions to remember), large backlit display, timer function, 20 amp current scale and many more.

Other Features: • True RMS mode • Large display includes main and sub displays with bargraph • 10 Location memory • Stop watch/presettable count down timer • Minimum, maximum, average and relative modes • Decibel measurement • Capacitance and inductance measurement • Temperature mode (°C and °F) • Pulse signal generator for logic and audible testing etc • Continuity and diode test • Logic test • Auto power "off" and "keep on" mode • 20A current range • Warning buzzer sounds when leads are incorrectly inserted in the 20A current mode • Back lit display • Data hold and run mode • Low battery indication • Overload protection • Safety design in compliance with UL 1244 and VDE0411

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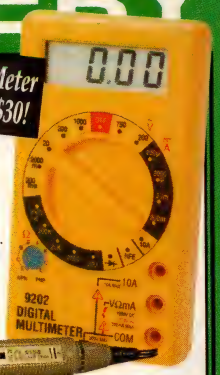
Highly Recommended for Scientific Research & Development Work

Q 1091 **$229**

19 Range Digital Multimeter

Amazing Meter for Under $30!

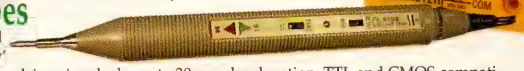


After evaluating 30 or more meters of this calibre we found the Q 1053 to be the best value for money by far!

This 3.5 digit multimeter features a 19 position, easy to use rotary switch for function and range position. Includes AC/DC voltage check, 10A DC current, resistance, diode and a transistor test function. This meter offers many of the features of much more expensive models but at the fraction of the cost. Ideal for the cash strapped student, or budding enthusiast!

Q 1053 Normally $39.95, **This Month Only**

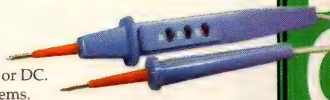
Logic Probes



Features audio and visual 'hi' and 'low' indication. Detects pulsing signals down to 30ns pulse duration. TTL and CMOS compatibility at the flick of a switch. Makes observation and fault finding of any digital circuit easy!

Q 1272 20MHz Logic Probe **$39.95**

AC/DC Low Voltage Test Probe



Ideally suited for tracing or locating voltages up to 24V AC or DC. Excellent for working on cars, boats or trucks electrical systems. Simply place one probe to earth and place the other probe onto the wire to be checked. If voltage is available the corresponding (6, 12 or 24V) LED will light. Very simple to use.

Q 1230 **$7.25**

Super Compact Car / Motorcycle Alarm

Exclusive to Altronics

Super compact in size, this alarm features shock sensor (with adjustable sensitivity), voltage drop sensing (can be disabled) and negative trigger input (for door, boot and bonnet etc). Wireless remote control with arm/disarm and panic functions. Will flash car indicators or park lights when arming and disarming. All the electronics and piezo siren are housed inside one neat enclosure measuring only 100L x 75W x 45H mm, making it ideal for cars and motorbikes. Supplied complete with a flashing dash mounted LED and wiring harness.

Protect your car from theft. Install one of these alarms & save hundreds $$$ on comparable systems!

Features: • Remote controlled (≈15m range) • 110dB piezo siren built into controller • Very compact size • Voltage drop sensing circuit (selectable) • Audible arming / disarming with trigger indicator • Built in adjustable shock sensor • Remote panic • Negative trigger input • Triggered memory • 30 second reset and rearm after triggering • 25 second arming delay • 10mA current draw in armed mode

S 5210 Alarm Only **$99**

S 5211 Additional Remote Control **$16.95**

High Power 6 Tone Sirens

Massive 120dB Output!

Scoop Purchase! Normally $39.95 Save Over 50%

Continuously cycles through 6 different alarm sounds, each of 6 seconds duration. Each tone can be enabled/disabled via internal DIP switches. Certainly attracts some attention! Requires 12V DC at 1.2A. Dimensions ≈80mm Ø by ≈80mm Long (excluding the bracket).

Hurry, Stocks are Strictly Limited at This Price

S 6134 **$19.95**

Tuning Meter with Centre Zero

We have a limited quantity of tuning meters. Their sensitivity is 250µA half scale. You will need to be quick at this price. Ideal for project radios etc. Hurry stocks limited.

Q 0600 Normally $5.95, **This Month** **$3.00**

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Professional 4 Sector Digital Alarm System with Auto Dialler

Amazing Value! As used by Many Commercial Alarm Installers Australia Wide.

This alarm panel is the same type as used by many commercial alarm companies to protect both residential and commercial properties.

Incorporating an inbuilt Austel approved auto-dialler, this great alarm can be configured to automatically dial two preset numbers in the event of an alarm, i.e. could be configured to automatically ring a neighbour or an alarm monitoring company. The main controller circuitry is housed in a sturdy steel cabinet. Provision is made to house an optional back up battery if required. The keypad control unit is generally located at the front door for easy access to arming and disarming of the system. The entire system is controlled and programmed via this keypad. Virtually any type of sensor can be used with this system. A combination of normally open and normally closed sensors can be used on any zone. Each zone is monitored by end of line resistors to maintain system integrity, i.e. if someone interferes with the system wiring the alarm will sound immediately.

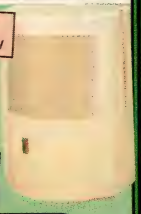
Features: • master code and three adjustable user codes • monitor function which test features like battery backup and mains failure • four individually programmable sectors with a large array of functions available • all four sectors utilise extensive noise protection circuitry and end of line resistors for added security • once triggered the alarm has the option of a silent alarm, and dialling a friend or monitoring company • quick arming option • zone bypassing for sectors which are false triggering • bell test - to test the external sirens without dialling out • door chime mode for entry/exit paths • battery backup • home or away operation • accessible alarm memory for confirming which sectors were triggered • separate instruction and installation manuals • 12 months warranty

S 5490 **$299**

M 9140 16V AC Plug Pack with Earth to Suit $32
S 5065 12V 1.2AH Backup Battery to Suit $32.50

PIR Movement Detector

5 Year Warranty



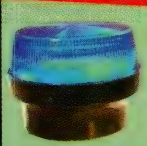
Small and sleek this detector is ideal for the home or the office. Range up to 13 x 13m. **Features:** • LED On/Off Jumper • Vertical Adjustment • Wall/Corner Mounting • Small Size - 62w x 88h x 48d mm • 5 Year Warranty

S 5307 **$49**

Ideal for the S 5490 Alarm Opposite

Amazing Bonus Package
Over $100 Value of Installation Accessories Including Cable, Strobe & Siren Free with Each Alarm System Purchase!

50 Metres of High Quality 4Core Security Cable (Sufficient for average 4 bedroom house). W 0356



High Intensity Strobe S 5445

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ALTRONICS SURVEILLANCE ALARM SYSTEM FITTED HERE

2 Large Alarm Stickers - S 5400
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ALTRONICS COMPONENTS

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Professional Gas Iron Kit

The advanced *CADIK* Soldering Iron offers a convenience and a range of functions that redefine the limits of soldering. This kit consists of the *CADIK* Gas Soldering Iron supplied in a handy carry case with a range of tips and accessories.

Features: • See through gas chamber • Built in ignition cap • Uses standard butane gas • Supplied with safety stand, cleaning sponge, solder dispenser, blow torch, hot air blower and hot knife cutter

T 2502 Normally $74.95, **This Month Only** **$49.95**

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Micron Soldering Station

Electronic Temperature Controlled, Temperature Selectable, Soldering Station

Features heavy duty 60 watt element, variable temperature control (320° to 440°C), LED bargraph temperature readout, quality silicon lead, light weight handle, sponge tray, and super heavy duty iron clad tips etc. Range of tip sizes available.

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4 Channel Economy Mixer

This compact mixer has inputs suitable for microphone, record players, camera audio, CD, Tape, and Tuner etc. Ideal for amateur cinematographers who would like to add their own background music and/or voice overs. Includes inputs for microphone, phono (with magnetic or ceramic cartridge), camera audio and an auxiliary (CD, tape, tuner etc). Features headphone output and master volume control. Requires

A 2520 Normally $119.00, **This Month Only** **$99**

M 9004 9V DC 300mA Plug Pack to Suit **$10.95**

Nibbling Tool

Buy Both for **$39** and Save Over 15%

For steel, plastic and aluminium. Capacity: 1mm for steel, and 1.6mm for aluminium, Ideal for the hobbyist and technician who want a professional appearance for their projects.

T 2355 Normally $21.95

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Ideal for Hi-Fi extension, surround sound or outdoor use. 8 Ohm 30 Watts.

Features: • Rugged UV stabilised 'Luran S' moulded enclosure • Engineer designed in Australia • Excellent reproduction • Superior to imports - yet a fraction of the price • All exterior fixings marine grade stainless steel • Speaker cones treated with special formula to repel moisture Dimensions 155W x 115D x 230H mm

Save a Massive $120

"Compared more than favourably in performance and looks to expensive imports costing twice as much" John Negus - Leading WA Audiophile

C 0904 White
C 0905 Black

Normally $160 ea
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$199 pair

Includes Unique 'Wacki' Mounting Bracket

Stereo 60 Watt 8 Ohm Attenuator

Fully self contained on a single gang switch plate. Supplied with mounting block. Complete with wiring instructions. Ideal for patio, Hi-Fi extension speakers etc.

A 2300 **$49.95**

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Now Supplied With Doubled Cushioned Headband for Extra Comfort!
This Month Receive a FREE Carry Case Valued at $19.95 Limited to First 100 Callers

1000's Sold Across Australia-Includes 2 Year Warranty!

It was not to long ago when spending $450.00 on an Aviation Headset was not uncommon. Altronics changed all that when we released our C 9070 Aviation Headset for $199.00. Add to this enhanced microphone, improved lead shielding and headband comfort these headsets must be the best value for money in Australia!

C 9070 **$199**

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Build a Jacob's Ladder display & amaze your friends

Ever since scientific showmen like Tesla and Edison were able to generate really high voltages, the Jacob's Ladder display has been creating awe amongst laymen. In this article, we show how you can build your own Jacob's Ladder using a low cost circuit.

By LEO SIMPSON & JOHN CLARKE

Virtually any high voltage power supply which generates more than about 10kV (DC or AC) can be used to provide a Jacob's Ladder display. The display consists of two vertical wires close spaced at the bottom and splayed apart to increase the gap as the spark rises.

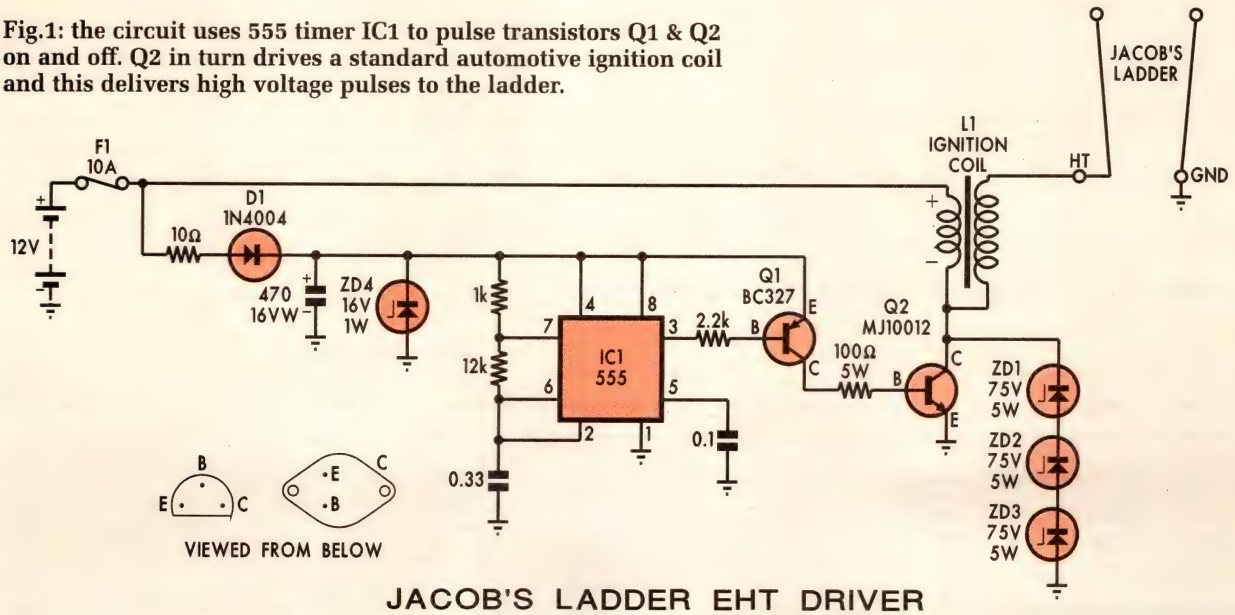
It is the paradoxical nature of the ladder discharge which intrigues most people. Who would believe that the spark would want to become longer and travel upward, seemingly defying gravity? And surely the spark would take the shortest path rather than extend itself as it travels upward.

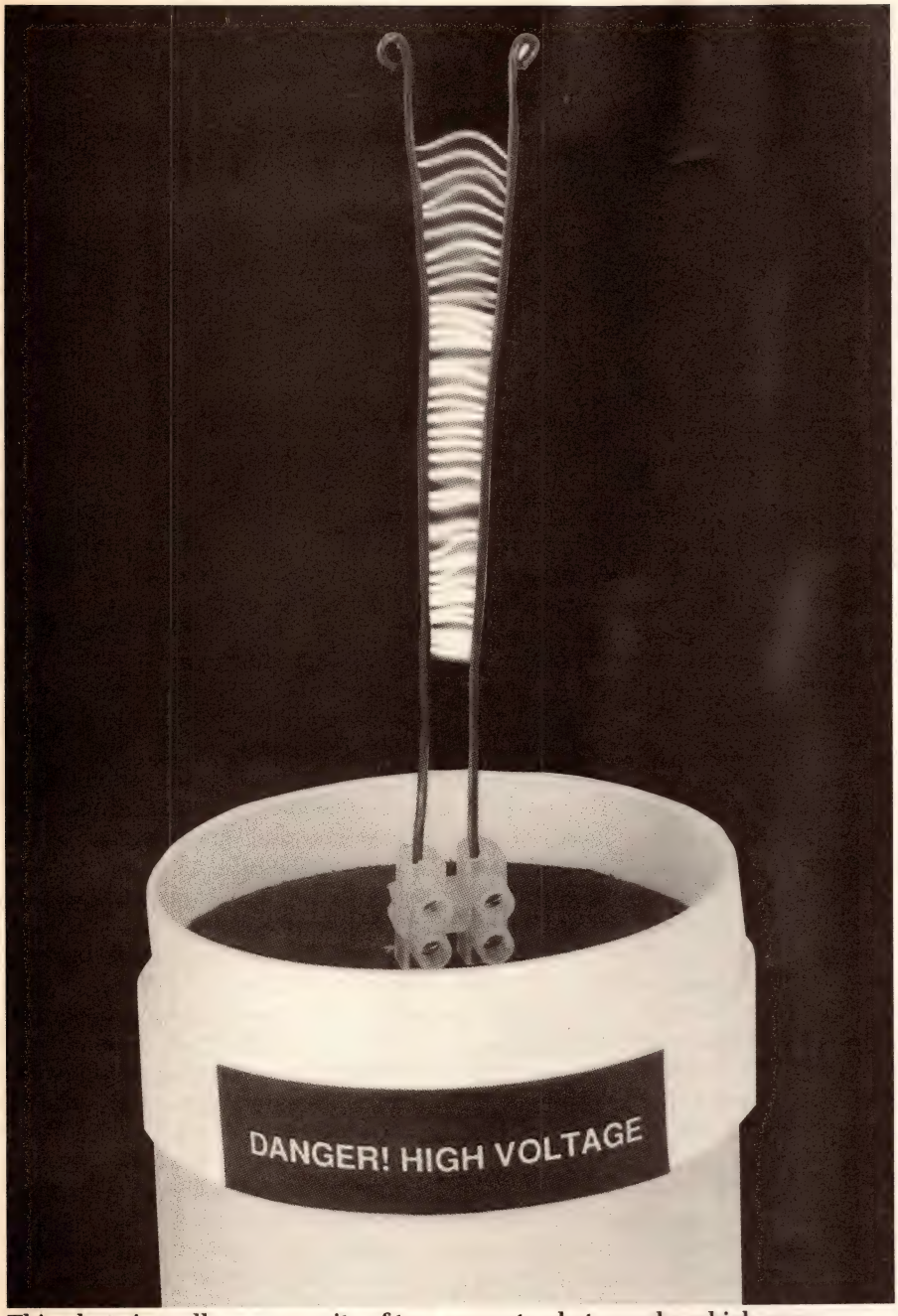
In reality, the spark discharge is taking the easiest route from one electrode to the other. Initially, the discharge does take the shortest path which is at the bottom of the wires. But the Jacob's Ladder display works because the continuous spark discharge gets hot and heats up the air around it. This heated ionised air rises, carrying the discharge with it until the gap is too wide to maintain the spark. The discharge then starts at the bottom again and works its way back up and the cycle continues.

Why is it called a Jacob's Ladder? We don't know who first came up with the name but it is an allusion to the Bible story of Jacob: "He dreamed that he saw a ladder standing on the earth, with its top reaching into heaven; a stairway for the angels of God to go up and come down" (Genesis, XXVIII;12).

The high voltage supply is easy – either of the plasma bottle displays from the August or November 1988 issues of SILICON CHIP will do the trick but there is a better approach – adapt the low cost Electric Fence Controller from the July 1995 issue of SILICON CHIP. A kit for this design is available from Dick Smith Electronics and from Jaycar Electronics and only requires a few simple modifications.

Fig.1: the circuit uses 555 timer IC1 to pulse transistors Q1 & Q2 on and off. Q2 in turn drives a standard automotive ignition coil and this delivers high voltage pulses to the ladder.





This photo is really a composite of two separate photographs which were combined using a computer. It shows how the spark climbs the ladder formed by the two vertical wires attached to the ignition coil. Note that the multiple discharge paths shown here are a result of the ¼-second exposure time used when taking the photo. In practice, fewer sparks are visible at any one time.

PARTS LIST

1 PC board, code 11306951, 171 x 79mm
1 12V ignition coil (see text)
3 280 x 5mm cable ties
5 PC stakes
2 3AG PC mount fuse clips
1 10A 3AG fuse
2 5mm ID crimp eyelet terminals
1 TO-3 transistor insulating cap
2 3mm screws, nuts and star washers
1 red battery clip
1 black battery clip
1 ignition coil EHT connector
1 2-way terminal block
1 2m length of twin red/black automotive wire
1 60mm length of red heavy duty hook-up wire
1 60mm length of blue heavy duty hook-up wire
1 370mm length of 1.5mm copper wire
1 40mm length of 0.8mm tinned copper wire

Semiconductors
1 555 timer (IC1)
1 BC327 PNP transistor (Q1)
1 MJ10012 500V NPN Darlington (Q2)
1 1N4004 1A diode (D1)
3 75V 5W zener diodes (ZD1-ZD3)
1 16V 1W zener diode (ZD4)

Capacitors
1 470µF 16VW PC electrolytic
1 0.33µF MKT polyester
1 0.1µF MKT polyester

Resistors (0.25W 1%)
1 12kΩ
1 2.2kΩ
1 1kΩ
1 100Ω 5W
1 10Ω

Actually, using the Electric Fence Controller to generate the spark discharge provides a big advantage in that the resulting Jacob's Ladder is much more spectacular. Instead of having just one spark discharge which climbs up the wires, our version produces about 130 sparks second, so you have a whole series of sparks which appear to be climbing up the wires, as shown in the accompanying photo.

The result is noisy and smelly, and all those sparks look quite nasty and dangerous – as indeed they are.

How it works

The Jacob's Ladder is based on an automotive ignition coil. These can be purchased new from automotive retailers but will be cheaper if purchased secondhand from motor wreckers. Select one which requires a ballast resistor.

The circuit comprises a 555 timer IC, two transistors, the ignition coil and several resistors, capacitors and diodes – see Fig.1. The revised circuit pulls a lot more current than the Electric Fence Controller and generates lots of fat, juicy sparks instead of the deliberately restricted high voltage transients of the original circuit.

IC1 is a 555 timer used to produce the short pulses. Note that we used a standard 555 timer here since it is more rugged than the CMOS (7555) version and less likely to be damaged by any high voltage transients which

The ignition coil is secured to the PC board using plastic cable ties, while a plastic cap is fitted to Darlington transistor Q2 to prevent unexpected shocks during testing. Note that you don't have to buy a new coil – a secondhand coil obtained from a wrecker's yard will do the job quite nicely.

may be present on the PC board.

IC1 is connected to oscillate at about 133Hz, as determined by the 0.33µF capacitor at pin 6 and the associated 12kΩ and 1kΩ resistors. The two resistors set the duty cycle of the pulse train delivered by pin 3 at essentially 14:13; ie, close to a square wave.

When pin 3 is high, transistor Q1 is held off and no base current flows in Q2. When pin 3 goes low, Q1 is switched on due to the base current flow through the 2.2kΩ resistor and Q1 switches on Q2 via its 100Ω base resistor. The coil now begins to charge via fuse F1. The instant pin 3 goes high again, Q2 switches off and the coil develops a high voltage and generates a spark across the gap.

Q2 is an MJ10012 Darlington power transistor, specifically designed as a coil driver in automotive ignition systems. It has a 500V collector-emitter rating so it can withstand the high voltages developed across the coil's primary winding.

Depending on the spark gap, the coil's peak primary voltage will only be about 200V or so, but if the gap is very large or the coil is operated without any EHT output lead, the secondary voltage can be excessive and there can be a flashover inside the coil. Not only can this damage the coil but it can also produce a very high primary voltage which may damage Q2.

Accordingly, three 75V 5W zener diodes, ZD1 to ZD3, are connected in series across Q2 to limit the primary voltage developed by the coil to about 225V, well within the transistor's rating of 500V.

Power supply

Power for IC1 is provided by the battery via fuse F1, the 10Ω resistor and diode D1. A 470µF capacitor filters the supply to provide reliable triggering for the timer. Transient protection is provided with ZD4, a 16V zener diode. A 0.1µF capacitor at pin 5 filters the trigger point voltage to ensure that the timer does not false trigger.

Diode D1 offers reverse polarity protection for IC1, while the fuse protects the battery from supplying excessive current should a fault occur.

Construction

The circuit is constructed on a PC board coded 11306951 and measuring 171 x 79mm. This board, together with the ignition coil mounted on it, fits neatly inside a 230mm length of 90mm plastic stormwater pipe (available from plumbing supply outlets). Fig.2 shows the assembly details for the PC board.

Begin the assembly by installing PC stakes at the five external wiring points. This done, solder in all the low profile components such as the IC, diodes and resistors. Table 1 lists the resistor colour codes but it is also a good idea to check the resistor values using a digital multimeter before soldering them in position.

Now solder in the capacitors, taking care to ensure that the 470µF electrolytic is oriented as shown. Take care to ensure that the semiconductors are correctly oriented as well. In particular, note that D1 (1N4004) faces in the opposite direction to the three zener diodes (ZD1-ZD3). Note that ZD4 is mounted under the PC board across the 470µF capacitor. Pin 1 of the IC is adjacent to a notch in one end of the plastic body.

Transistor Q1 should be pushed down onto the board as far as it will easily go before soldering its leads. Q2 is secured directly to the board (ie, no insulating washer) using 3mm machine screws and nuts.

As well as securing Q2 in place, these mounting screws and nuts also connect Q2's collector (ie, the case) to a track on the PC board. To ensure reliable connections, use star washers under the screw heads and solder the nuts to their surrounding copper pads. This done, fit an insulating cap to Q2 – this will prevent any nasty shocks during the testing procedure.

The 100Ω 5W wirewound resistor is mounted about 6mm above the PC board, to avoid any possibility of charring – it does get hot.

TABLE 1: RESISTOR COLOUR CODES

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	12kΩ	brown red orange brown	brown red black red brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	10Ω	brown black black brown	brown black black gold brown

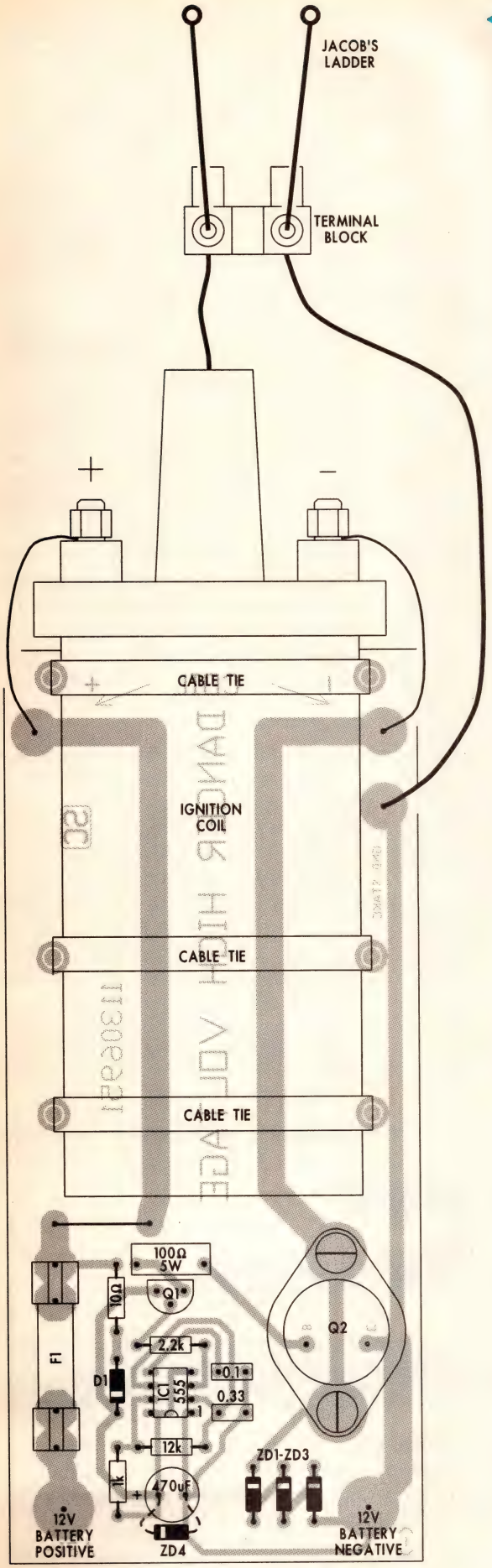
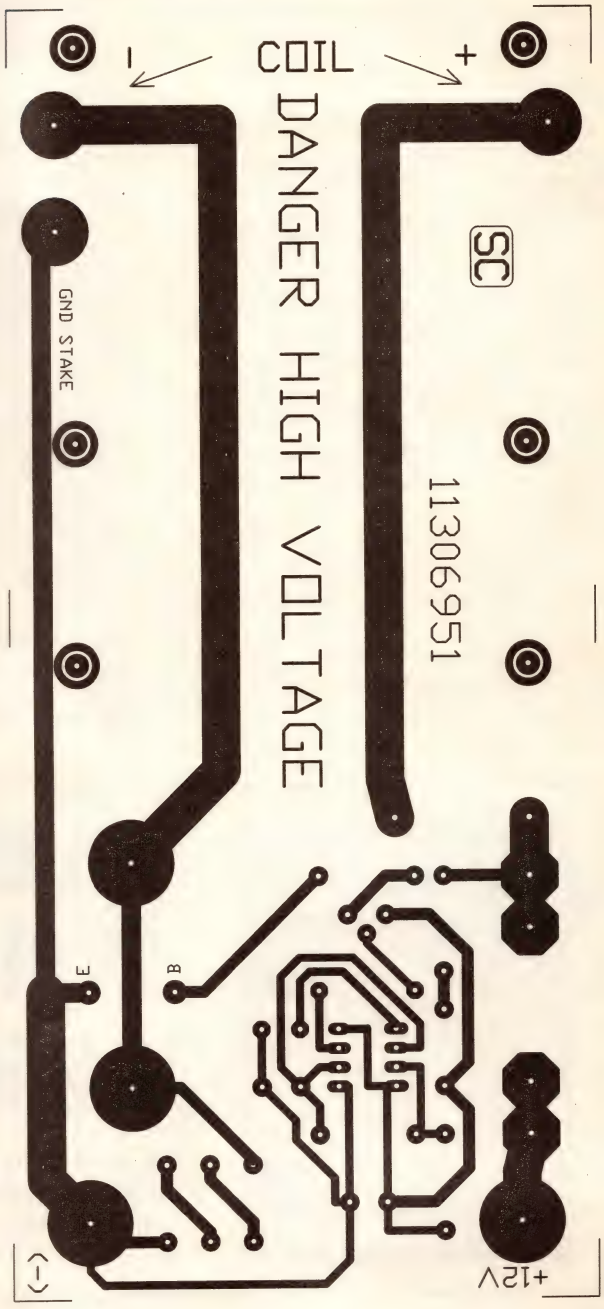


Fig.2 (left): install the parts on the PC board as shown in this wiring diagram, making sure that all polarised parts are correctly oriented. The EHT connection to the coil is made using a brass EHT ignition coil connector.

Warning!

This Jacob's Ladder display uses very high voltage which can give a nasty shock. Do not put your fingers near the display or coil while ever the power is applied.

Fig.3 (below): check your PC board for defects by comparing it against this full-size etching pattern before installing any of the parts.



The fuse clips can now be installed. Note that these each have a little lug at one end to retain the fuse after it has been installed. These lugs must go to the outside ends, otherwise you will not be able to fit the fuse.

The ignition coil is secured to the PC board using three cable ties (see photo), after which the leads can be run to its primary terminals. These leads should be terminated using 5mm eyelet connectors to allow for easy connection to the coil. Don't just crimp the connectors to these leads – solder them as well to ensure long-term reliability.

Finally, complete the construction by fitting the twinlead battery cable (red to positive, black to negative). The free ends of this cable are fitted with large (30A) battery clips

Testing

Before you apply power, you must provide a temporary spark gap for the ignition coil, otherwise it could be damaged, as noted above. The gap can be made quite simply with a paper clip. Extend the paper clip so that you have a hooked section at each end. Fit one hook into the EHT socket on the coil and make sure that it cannot fall out easily. This done, bend the other end of the clip so that it is close to (less than 5mm) but not touching the negative primary connection of the coil.

Now for the smoke test. Immediately, there should be a continuous spark across the temporary spark gap. Do not attempt to touch any part of the coil while power is applied because it can give you a very nasty shock!

A large coffee jar placed over the ladder will prevent high-voltage shocks, although it does tend to diminish the spectacle of the display.

If everything works OK, disconnect the battery leads and carefully slide the assembly into its 90mm tubular plastic housing. This done, feed the battery cable through the hole in its end cap, secure it using a cordgrip grommet and reconnect the leads to the PC board.

The board assembly will be held in position when the end caps are fitted and, generally, this should be sufficient. However, if you wish the board to be held even more securely, wrap a small amount of foam rubber around the top of the coil so that the assembly is a tight fit within the tube.

We made our Jacob's Ladder spark gap with a 220mm length and a 150mm length of 1.5mm copper wire. The shorter length was soldered to an ignition connector which plugs into the coil EHT, while the longer wire was soldered to the GND terminal. We used a 2-way terminal block to separate the wires at the base of the ladder. If enamelled copper wire is used, scrape the insulation away along the inside edges to allow the spark to travel freely.

No kinks

Note that the two wires should be as straight as possible without any kinks. Any slight kinks will mean that the sparks will not progress smoothly up the ladder but will tend to "stick" at the kinks. So keep the wires as straight as possible and splay them apart very slightly so that the gap at the top is no more than about 20mm.

You can also place a large coffee jar over the complete assembly for safety's sake (see photo) although this does tend to diminish the spectacle of the display. **SC**

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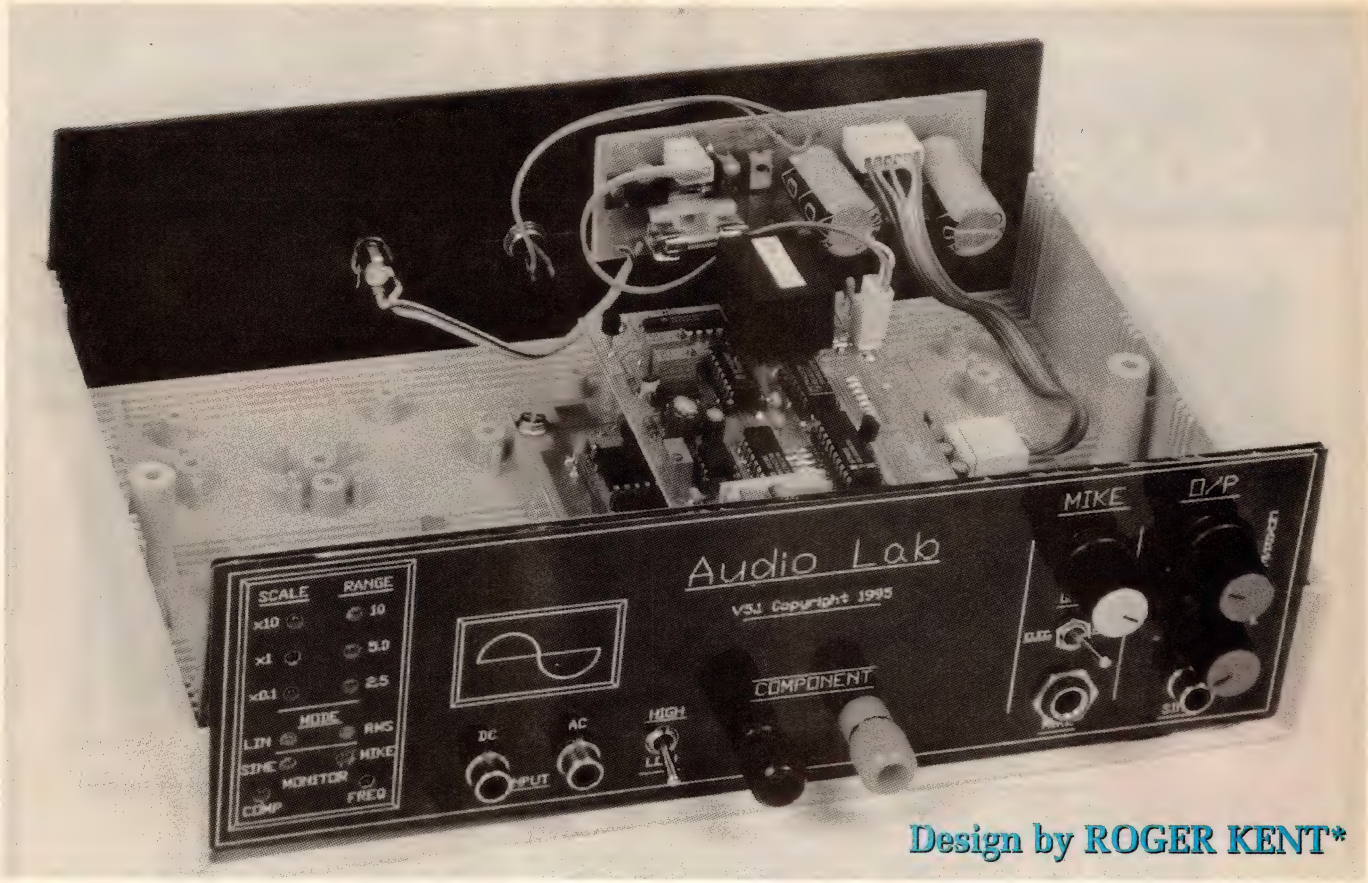


Design by ROGER KENT*

Audio Lab: a PC-controlled audio test instrument; Pt.2

In this second article on Audio Lab, we include all the circuit and wiring diagrams and give a rundown on the software. The calibration procedure includes 10 multi-turn pots and the software guides you through the full procedure.

In last month's article, the operation of Audio Lab and the functions of the various PC boards were described. Two more PC boards remain to be mentioned. The power supply board is fed by an external AC plugpack capable of delivering 1A. The 25-pin D connector for the serial port is also mounted on this board, together with the reset switch which is mounted on the rear of the case.

There is also an optional board for fault-finding on the Boot board. This consists of eight LEDs with limiting resistors and plugs into port P1 on the Boot board. How this is used will be described later in the construction details but before we move on to that topic we will discuss some of the system software.

System software

On power up, machine code software is dumped from the PC to Audio Lab via the serial port. To show the code has been successfully loaded, the LEDs on Audio Lab flash and a verification message is displayed on the PC. The opening menu screen is then accessed and the various meas-

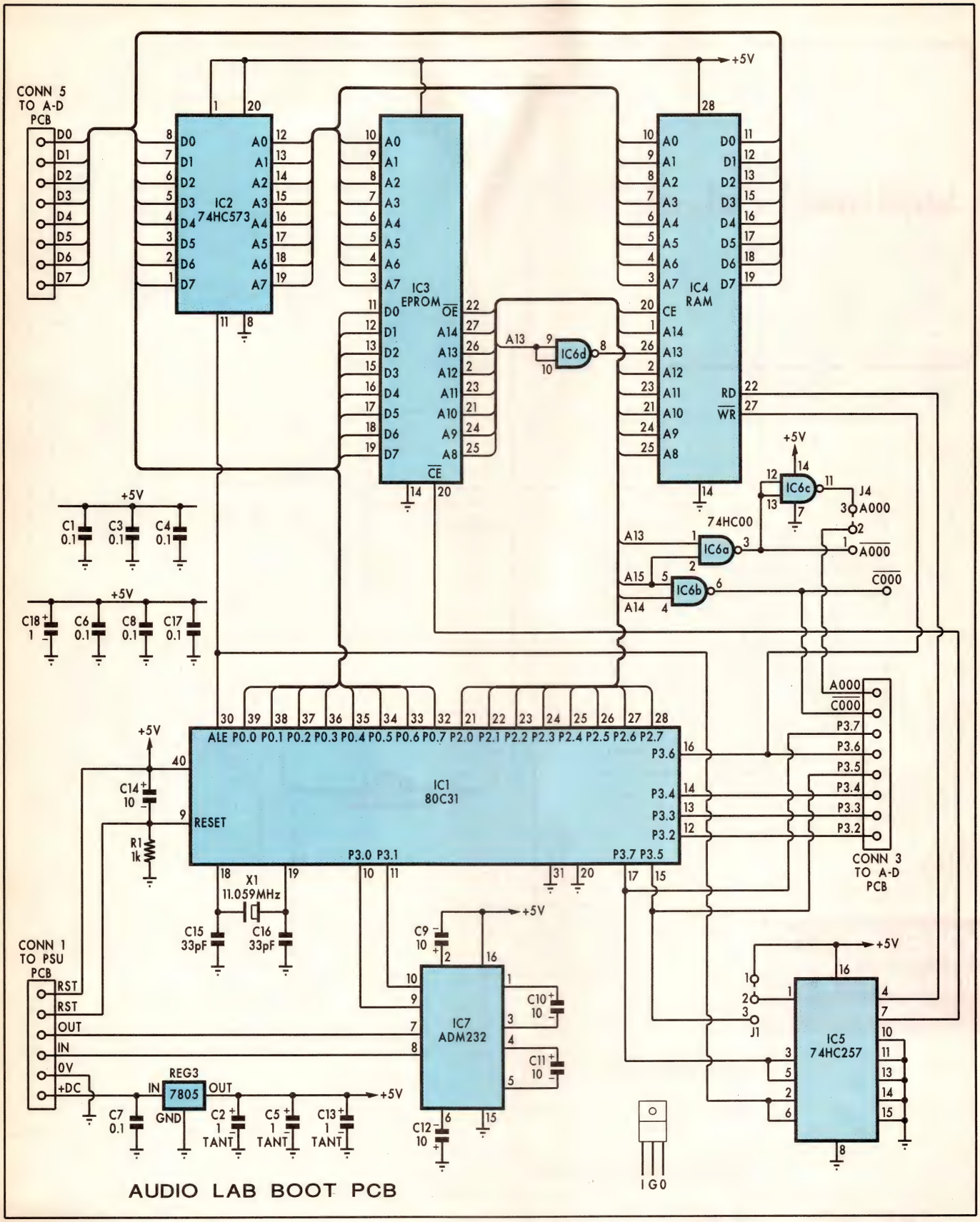


Fig.1: The boot board circuit contains the 80C31 microprocessor, the EPROM, RAM and the RS-232 interface chip.

urement options can be selected. The "Lab" screen consists of five main sections: a scope display which graphs the selected input, a display of the Audio Lab front panel which shows which Range, Mode and Monitor functions have been selected, two digital readouts showing the output frequency of the sinewave generator and

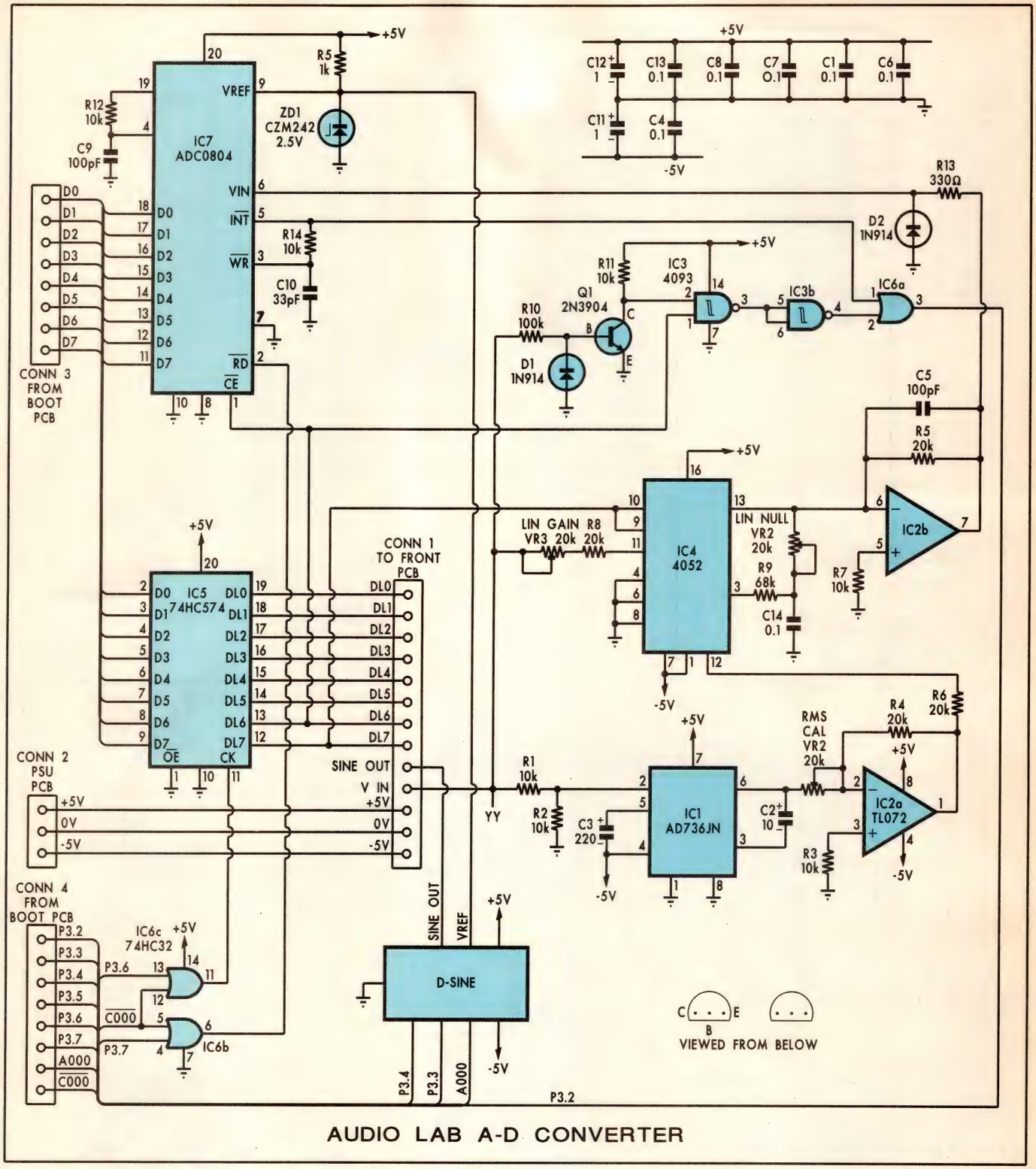


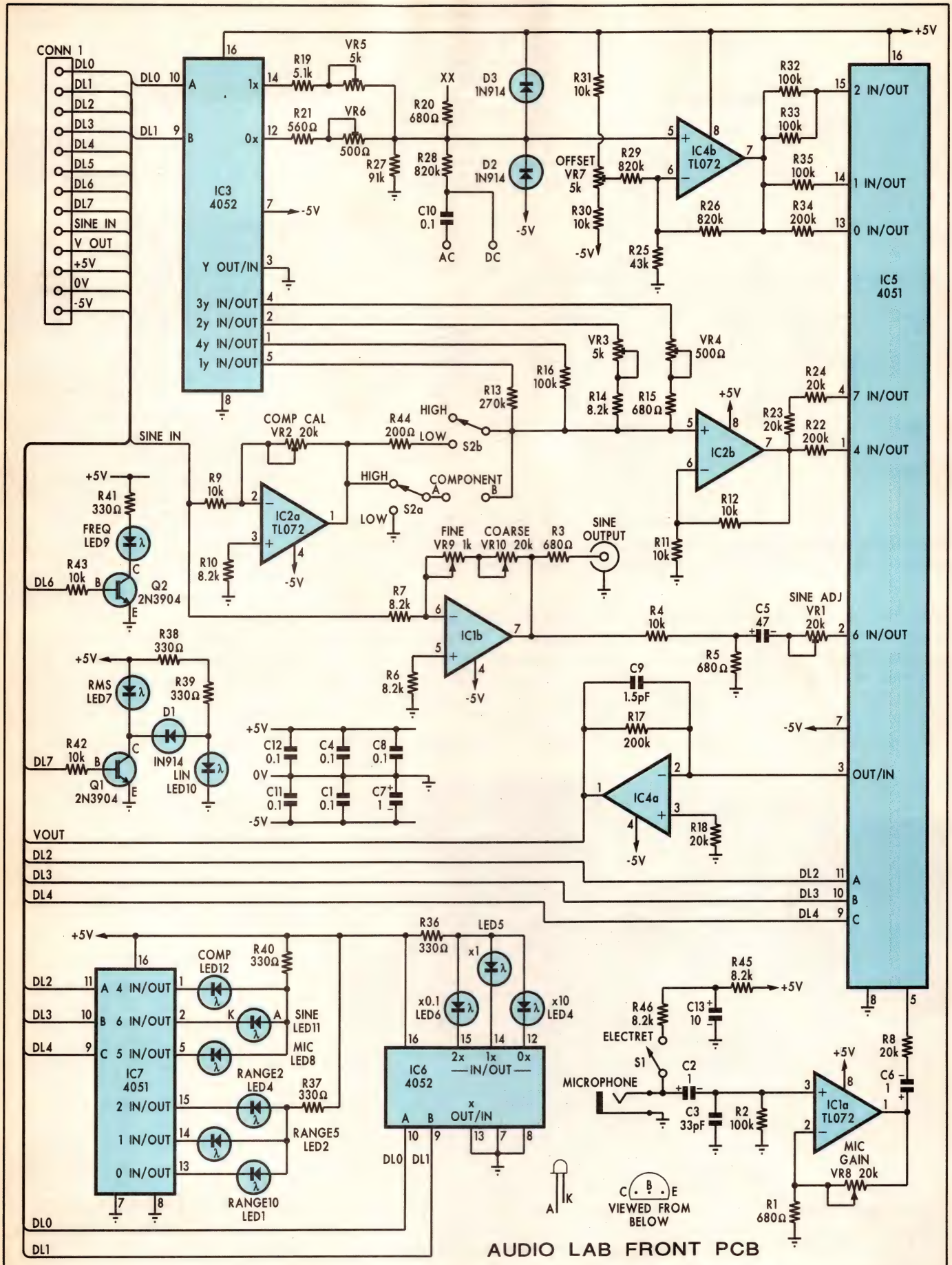
Fig.2 (above): the A-D converter board is based on an ADC0804 8-bit A-D converter and also features the AD736 true-RMS converter.

Fig.3 (right): the front panel board carries all the analog input circuitry and CMOS switches which are controlled by the 80C31 processor. 12 LEDs are used to indicate the various measurement modes.

the input voltage of the selected input, and finally, the Menu select bar at the bottom of the screen.

All the screens use the same method to select the different options. Any red item on the Menu bar has another screen or further options available when that function is selected by clicking the left mouse button. Items coloured green toggle between two options, and items coloured light blue signify that a selection of values is available.

For example, on the "Lab" screen the options on the menu bar are: "—", Input, Mike, Sine, Rms, Lin, *FREQ, *COMP, *SWEEP, Scroll and EXIT. To select an option, move the mouse un-



AUDIO LAB FRONT PCB

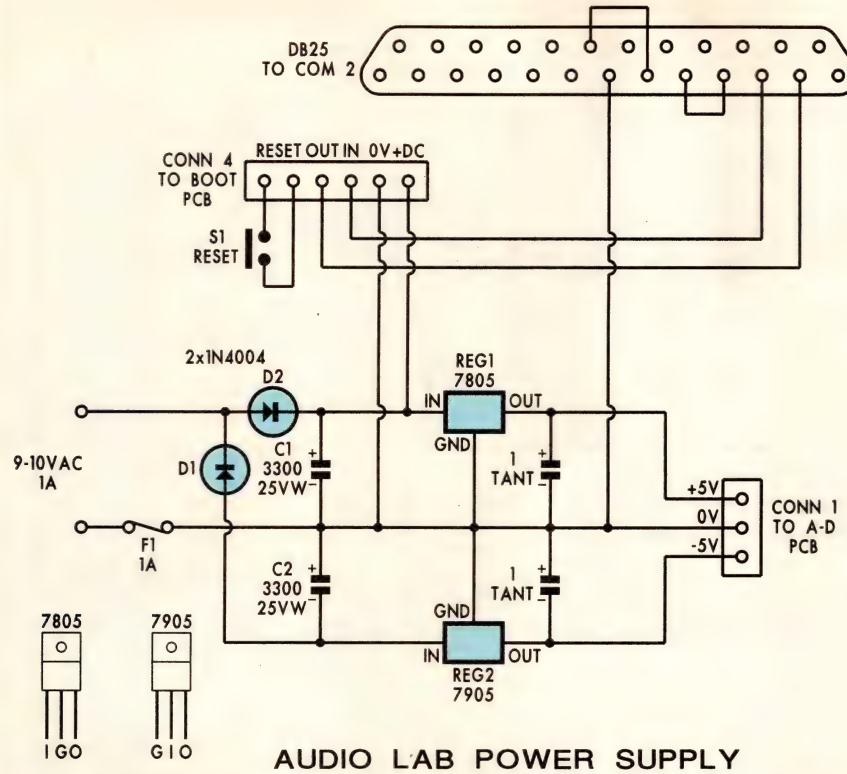
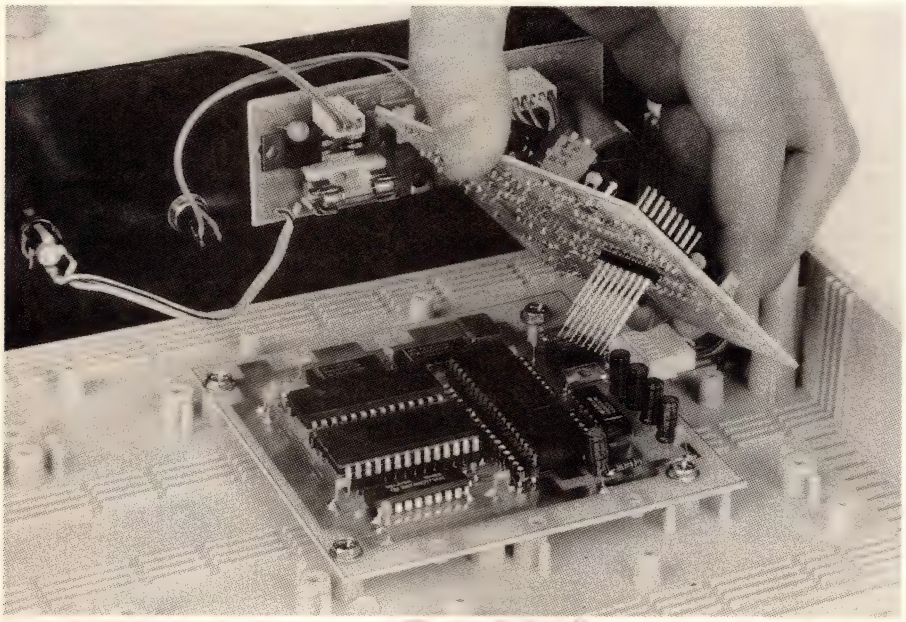


Fig.4: the power supply is fed from a 9V AC plugpack and uses two halfwave rectifiers together with 3-terminal regulators to produce the ±5V rails.

til the desired selection is highlighted in yellow. Press the left mouse button and the selection is made. If "Input" has been selected, then the first item on the menu bar changes to "Range" and the monitor input is switched to the input terminals. The range is shown on the LEDs and also on the video screen. If RANGE is now selected, the menu bar changes to enable the range of the input voltage required to be selected; ie, 250mV, 500mV up to 100V.

If "OPTS" is highlighted and the mouse clicked then the screen reverts back to the previous setting. "OPTS" always has this function from any screen. Similarly, if "Mike" or "Sine" is selected then the mike input or the sine output is monitored and displayed. "Scroll" is light blue and toggles between "Plot" and "Scroll" which are two different modes on the "Scope" display.



The A-D board plugs into the Boot board as shown in this photograph, with the interconnections made via two 8-way pin connectors (CONN3 and CONN5). The A-D board is then secured in position using Nylon spacers and machine screws and nuts.

Measuring components

If "*COMP" is selected, the component measuring facility is loaded. To use this, the setting of the High/Low range switch must be entered and if the switch is changed at any time, the setting must be re-entered, otherwise the calculations will be meaningless.

As described in last month's article, a two-component potential divider with one of the components being accurately known (P/Res) is used to measure resistance, capacitance and inductance. The software defaults to measure resistance with P/Res at 100kΩ and frequency of 1kHz. The scope screen and Volts display indicate the voltage with respect to zero (Vx) at the junction of the potential divider.

If the range switch is in the High position, then three values of P/Res are available: 1kΩ, 10kΩ and 100kΩ. By switching between these values, resistances from 200Ω to 10MΩ can be measured and displayed, as well as impedance. For a pure resistance, the displayed resistance and impedance will remain the same irrespective of the frequency applied to the potential divider. If the resistor under test is not "pure", (most wirewound resistors have significant inductance, for example), then the impedance will vary with frequency.

Low value inductances

Low value inductances can have significant resistance which causes misleading results when they are being measured. If LOW range is selected when measuring inductance, another option is available on the menu bar, namely S.res. When selected, this measures the impedance of low value inductors at 10Hz. The series resistance is measured, displayed, and then can be used when calculating the inductance.

The X1 and X5 toggles on the menu bar increase the resolution of the potential divider when measuring high

value impedances with the range switch set high, or low value impedances with the range switch set low.

Accuracy & resolution

As the measurements taken by Audio Lab are obtained by an 8-bit analog to digital conversion, the data has a maximum resolution of 255 steps. Also, because the equations used to calculate impedance are non-linear, the accuracy of the reading is a function of where in the range the measurements are taken.

The "Scale%" display gives an indication of this accuracy. This is not an absolute indication of the accuracy of the system but is calculated by computing the value of the impedance of the device under test at the next quantised step and displaying it as a percentage of the actual reading. This enables a choice to be made as to which combination of P/Res and frequency to use to obtain the highest accuracy.

The last selection on the menu bar is "*SWEEP". This also appears on the "LAB" screen and its function is identical. Being coloured red, this takes us to another screen where frequency sweeps are performed.

If entry to the Sweep screen is from the Component measure screen, then the selected active input is Component. If entry is from the LAB screen, then which ever input was enabled is active. The LEDs show which input is selected and this is also shown on the PC display. "G.Col" scrolls through the different colours of the graph plot. "Print" prints the graph to the printer. Toggle ".Xlin." and ".Xlog." selects either linear frequency sweep from the pre-selected start frequency with a selected frequency increment, or a full log frequency sweep from 10Hz to 20kHz. To save a project, click on *SAVE and to load or delete a previously saved project, select *FILES.

All the parameters associated with a given project are saved to disc, along with the sweep data, and if these parameters are not identical to the current parameters when loading a file, a warning of "Parameter Change" is given. This stops files that have been created and saved with different ranges, inputs, etc from creating misleading plots when multiple graphs are displayed simultaneously. However, this can be overridden if required.

"*SETUP" takes us to the last screen which is used to select printer options and the start and increment frequencies for the linear frequency sweep mode. A printer choice of HP Deskjet+, Epson 9-pin or Epson 24-pin emulation in either draft, final, landscape or portrait is available. If HP is chosen, resolutions of 300, 150, 100 or 75DPI can also be selected which give different size printouts.

At any time, a screen dump can be taken by pressing F10. This gives a different printout to the Print selected from the Sweep screen which only

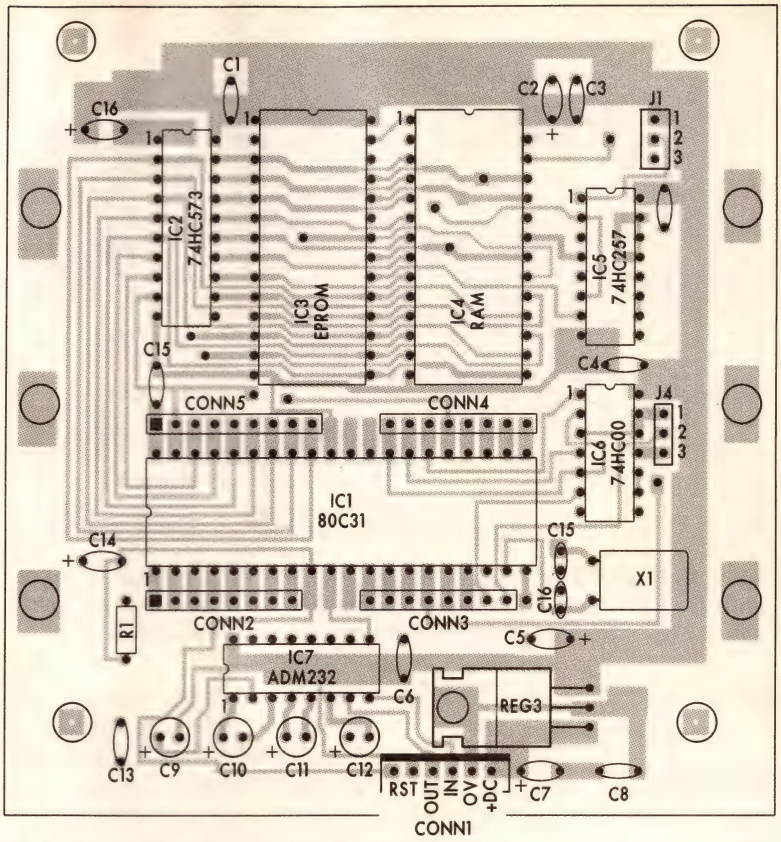
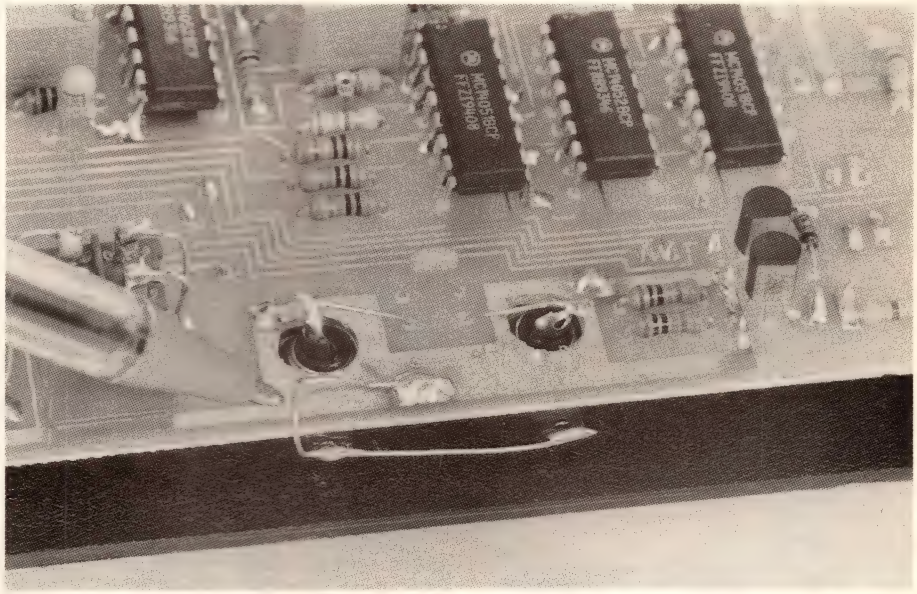


Fig.5: the component overlay for the boot board. Note that the crystal and 3-terminal regulator must lay flat on the board.



This view shows how the two RCA input sockets (DC & AC) are connected to the front panel board using short lengths of tinned copper wire. Note in particular how the two earth lugs are connect to the earth pattern on the board.

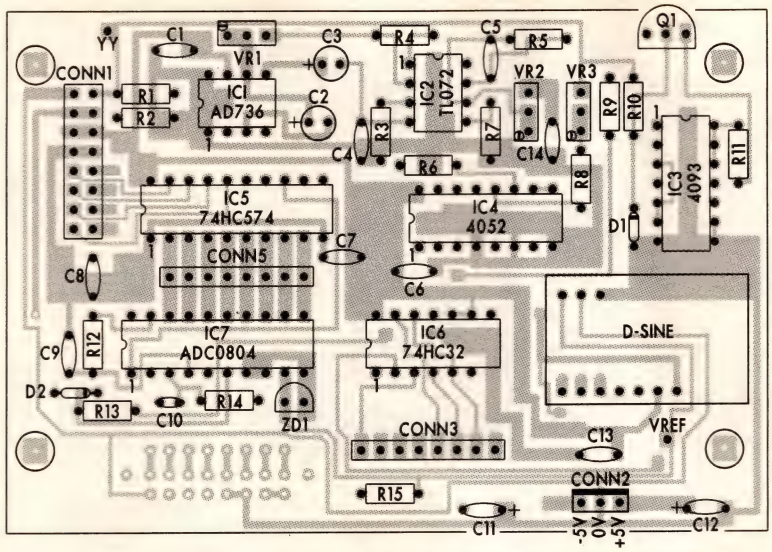


Fig.6: the component overlay for the A-D board. Care must be taken with the interboard connectors. It must be assembled onto the boot board before the interboard connectors are soldered in place.

prints the currently active graph along with the setup data.

Construction

All the PC boards are double sided, with plated-through holes, screened component overlays and solder masks so construction is quite straight forward. However, it is advisable to follow the sequence of assembly to ensure the correct alignment of the boards, especially the Front PC board. All resistors are 1% with 4-band codes. It is a good idea to check each resistor's value with a digital multimeter before it is soldered into place.

Fig.7: the component overlay for the front panel board. Note that the LEDs, sockets and binding post terminals must line up with the front panel.

To keep the stray capacitance to a minimum, when assembled, all the boards should be cleaned using a proprietary flux cleaning spray.

The power supply board should be assembled first, taking note of component polarities and ensuring the correct positioning of the 3-terminal regulators. Do not fit the 25-pin D connector yet. It is also important to observe the orientation of the connectors CONN1 and CONN4, making sure the pins face to the outside of the board. Connectors CONN2 and CONN5 are not used in this project.

Assemble the socket for the AC plugpack into the hole on the back panel and connect it to the "AC in" connections on the PC board. Solder two wires into the holes marked "RST", and connect them to the reset switch after it has been assembled into the back panel. Apply power and check the +5V and -5V rails on CONN1 and check for about +12V to +15V between +V and 0V on CONN4. If all is correct, then mount the D connector onto the back panel and solder the power supply board into place.

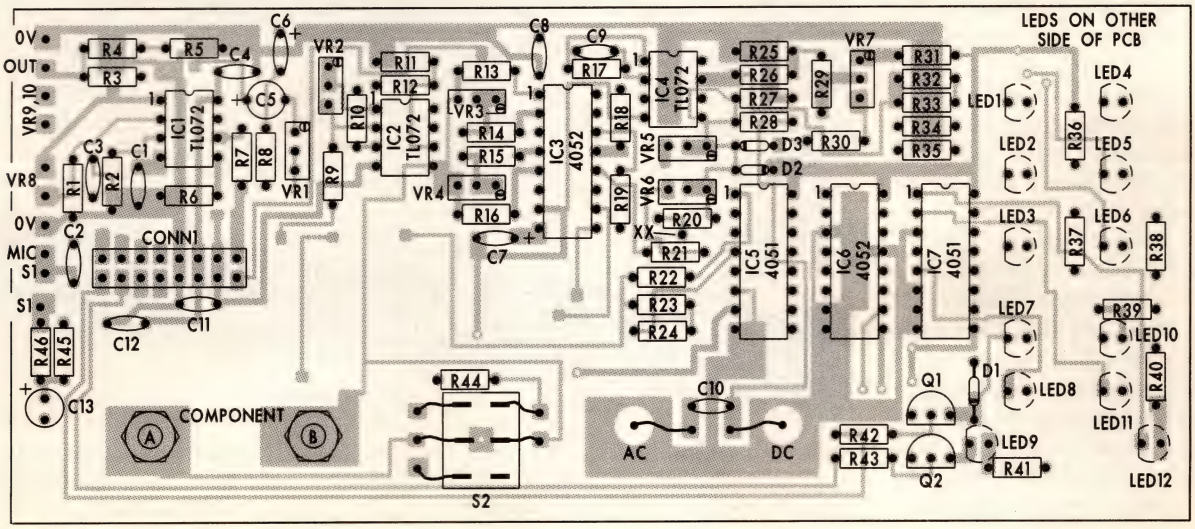
Assemble the 3-way and 6-way interconnecting cables, observing the correct orientation of the connections. The way to be sure this is correct is to place the connectors flat, so that both ends are facing away from each other and the location guides on both connectors are facing up. Then wire the connectors together with no twists in the cable.

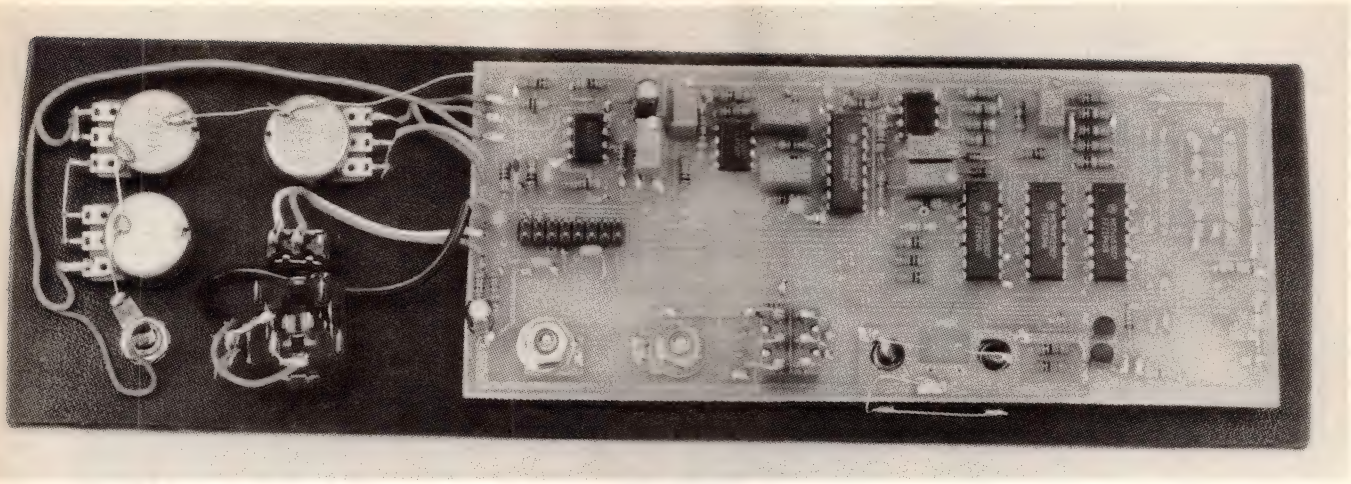
Boot board

This board should be assembled, using sockets for all the ICs. Take care not to overheat the crystal or ceramic capacitors. The 8-way socket strips are CONN3 and CONN2 while the 9-way strip is CONN5. CONN4 is not used. There are two links on the Boot board to select the running mode of the processor. On J1, link 2 and 3 to enable the run from RAM function, and on J4, link 2 and 3 to select the polarity of address A000H.

Before inserting any ICs, connect the 6-way cable from the power board to the Boot board. Power up and check that +5V is present between pins 40 and 20 on the microprocessor socket. Switch off and insert all the integrated circuits, observing correct orientation. Do not mount the boot PC board into the case at this stage.

If you are using the Test PC kit, the Boot and power supply boards can now be tested. After assembling the





The front panel board is secured using two sets of nuts on the binding post terminals. Be sure to orient the three potentiometers as shown here and note that the metal bodies of the pots are all earthed back to the PC board using tinned copper wire.

test PC board plug the board into the bus connectors on the Boot PC. The eight interconnecting pins go to port P1 on CPU pins 1-8, which is CONN2, and the 5V supply connects to pin 40 on the 80C3 which is the top pin above CONN5. Apply power and the LED connected to pin 1 should flash. Press the reset switch and the LED should stop, either on or off, and when the reset switch is released the flashing should restart.

If all is well, the CPU, EPROM, reset and decoding circuitry are functioning correctly. Power down and connect Audio Lab to the serial port on your the PC, using a standard 25-way male-to-female cable.

On the Calibrate/test disc is a program called LABTEST.BAT. Power on Audio Lab and the same LED will flash.

Now type LABTEST from A: drive. A small 8031 machine code program called "Test.bin" is now being dumped to the RAM at 9600 baud and the LED will flash faster. After installation, the LEDs will flash in order from P1.0 to P1.7 and an acknowledgment of correct data transfer will be shown on the PC. The RAM and Serial interface have now been tested and the Boot PC is functioning correctly. If any of these tests fail, check all components and the power cables to the boards.

A-to-D board

Assemble this board as normal but do not insert the IC sockets for IC5, IC7 or the PC board interconnecting strips. Connect the 3-way power cable and disconnect the 6-way cable from the Boot PC board. When powered up, check for +5V between pins 16 and 8 on IC4 and -5V between pins 7 and 8 on IC4. Turn the power off and disconnect the 3-way power cable.

Gently insert the ends from the plastic holder on the PC interconnecting strips into the two 8-way PC interconnecting sockets, CONN3 and CONN5 on the Boot PC, making sure they are seated all the way down. Note that the 8-way connector for CONN5 should start at the second pin down, leaving the top pin, marked +5, empty. Carefully position the A-to-D board and the pins into CONN3 and CONN5 (on the A-to-D board). Place the nylon spacers between the two boards in the holes marked A and C and screw together, with the nuts on the reverse of the Boot board.

Now solder the interboard connectors in place and also solder the nuts to the underside of the Boot board.

The boards can now be disassembled and the remaining IC sockets soldered in place and the ICs inserted. The Boot board can now be screwed into the case.

Carefully line up the A-to-D and Boot boards and bolt them together as before and connect the cables from the power supply to both boards.

Front board assembly

The interconnection between the A-to-D and Front boards is made via a 16-way cable which is provided ready assembled and tested. Assemble the Front PC board but do not insert the LEDs. The switch is mounted on the component side with the mounting nut on the copper side and links made between the holes adjacent to the relevant connector and the switch. The DC and AC RCA connectors should be fixed in place with the solder lug connectors facing down and slightly bent out to ease connecting to the Front board later.

Assemble all the components on the front panel, using only one nut on the two binding post terminals, and noting the orientation of the three front mounting pots, as shown in the above photo. Insert, but do not solder, the 12 LEDs on the copper side of the board, noting their polarity and colour which is marked on the PC overlay. Do not push them too far into the board. The Front PC is now offered up to the front panel and held in place with the

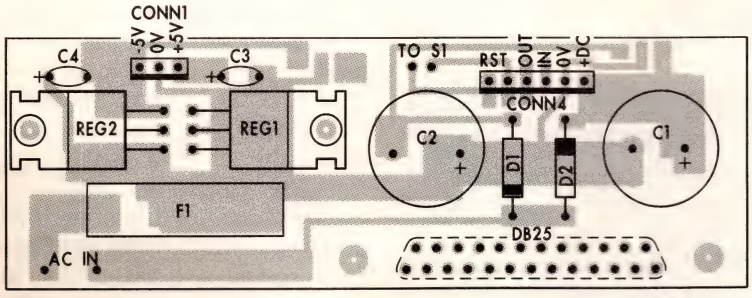
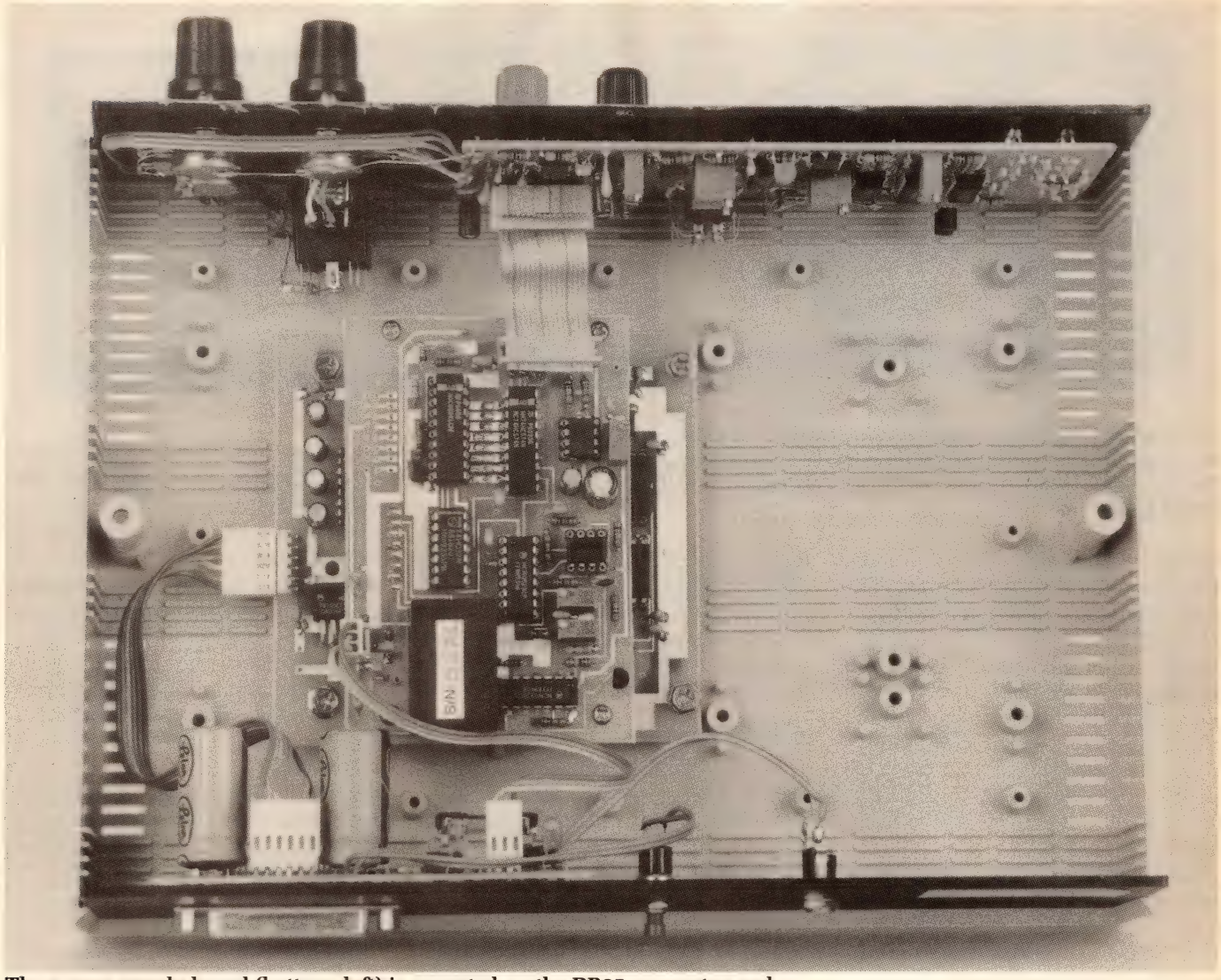


Fig.8: the component overlay for the power supply board. This carries the 25-pin D socket which mounts to the rear panel.



The power supply board (bottom, left) is mounted on the DB25 connector and is wired to the A-D and Boot boards via 3-way and 6-way cable assemblies. A 16-way cable connects the A-D board to the Front-Panel board.

remaining nuts on the two binding posts. The nuts should not be tightened but should just secure the board while allowing some movement and the switch should line up with the HIGH/LOW hole.

The LEDs will now line up with the holes in the front panel and can be gently pushed through the clearance holes until they are flush and poking through the panel. Slightly tighten the nuts on the binding posts and carefully solder the LEDs in place.

The front board can now be removed and the ICs inserted.

Reassemble the front board to the front panel and wire the pots, connectors and the ELEC switch as per the circuit diagram and component overlay on the PC board, using screened cable for the Mike connection. Connect the two earth connectors on the DC and AC input connectors together and link to the 0V terminal on the PC board. Link the centre connectors of the RCA sockets to their respective points marked on the board and tighten the nuts on the two binding posts. They can be soldered to the board later when the system has been tested and proved to be functional.

Calibration

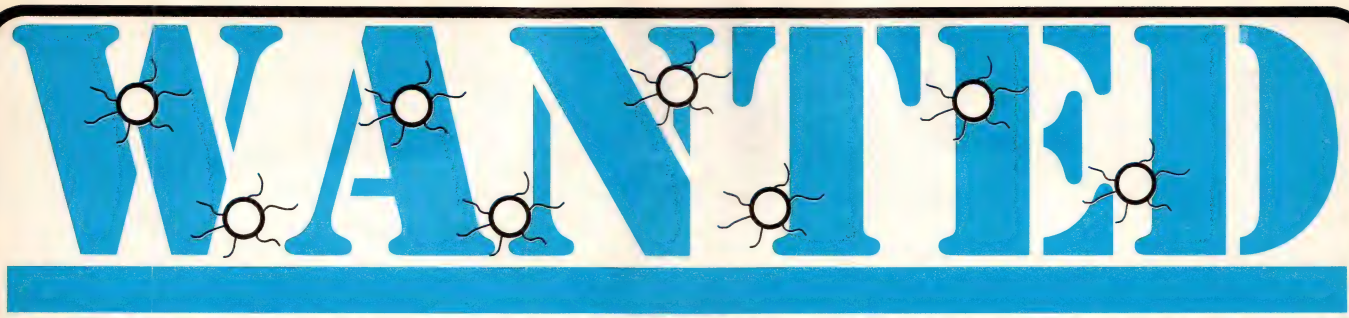
There are a total of 10 multi-turn pots in the Audio Lab but the calibration is made simple by means of the software. First, insert the Test/calibrate disk into the A: drive. Type install and a directory called C:\ALAB will be created and the software copied into this directory. Change directory to ALAB and type SETUP. This software steps through all the procedures involved in calibration, with a full graphic interface showing which pots to adjust and the reason for the calibration.

After calibration is complete, exit from the program and insert the disc marked ALAB into the A: drive and type INSTALL. The full suite of software will now be copied into C:\ALAB. To run the software simply type ALAB from the C:\ALAB directory.

Once you have mastered the simple menu system you will be able to flip from screen to screen. You should find Audio Lab an invaluable addition to your test equipment. **SC**

Kit Availability

Audio Lab is designed by R.S.K. Electronics Pty Ltd who hold the copyrights and sell the complete kit. Pricing details are shown in the advertisement elsewhere in this issue.



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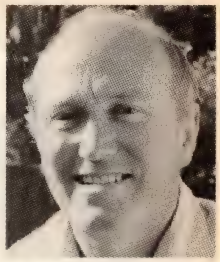


By JOHN HILL

An interesting grid bias problem

One of the more interesting aspects of vintage radio is repairing non-functioning receivers. As far as I'm concerned, getting them working again is the most satisfying part of this hobby.

As a person having neither an electrical or electronics trade background, I have never been properly trained to do radio repairs. I have developed my own repair techniques from reading books, asking others and doing my own investigations. As a result, there is a lot I have yet to learn and learning new things helps to maintain my interest in vintage radio.

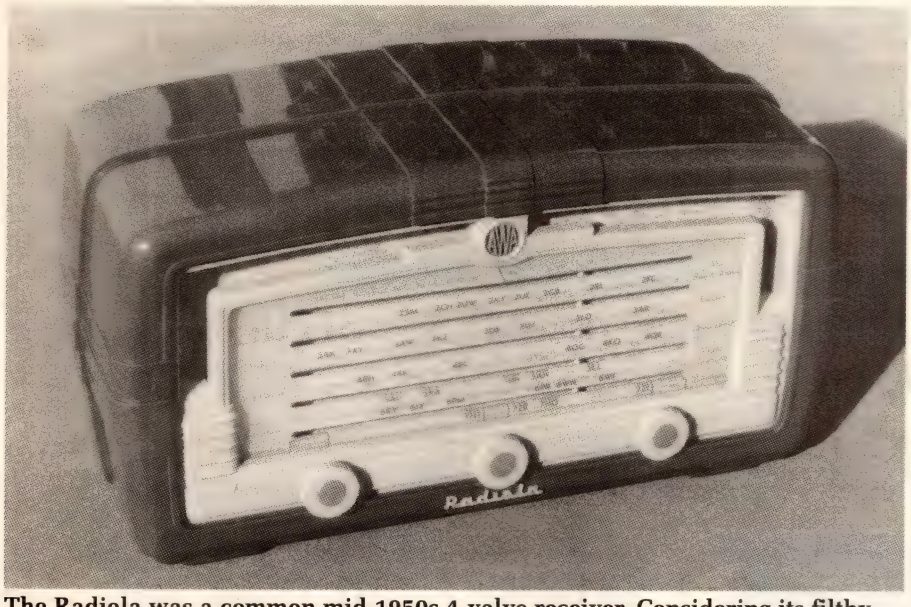
Having a limited background makes one easy prey to any new fault that comes along and these tricky problems always remind me of how inexperienced I really am. But perseverance usually wins and the fault is eventually found and rectified. Solving such faults is very satisfying.

A recent repair to a mid-1950s 4-valve Radiola produced one of these mystery faults and it proved to be quite elusive. Allow me to explain.

A real wreck

This particular receiver was one of the worst wrecks I have seen for a long time. It had obviously been stored for many years in a workshed, judging by the number of multicoloured paint splats that were on it. Why people have to flick their paint brushes at old radios I will never know!

The little Radiola was filthy and mouse infested. When the set was removed from its plastic bag there remained about a tablespoon full of mouse droppings and other miscellaneous items such as partly eaten pumpkin seeds, small bones and other debris. I hate working on sets like these!



The Radiola was a common mid-1950s 4-valve receiver. Considering its filthy condition when found, it scrubbed up fairly well.

After a thorough clean up, the usual checkout routine revealed that one of the oscillator coil windings was open circuit and the rectifier valve had almost no emission. As there were plenty of 6X4s in the valve box, the weak rectifier wasn't a problem but it did arouse a suspicion that there was something else wrong with the receiver to reduce the valve's emission to such a low level.

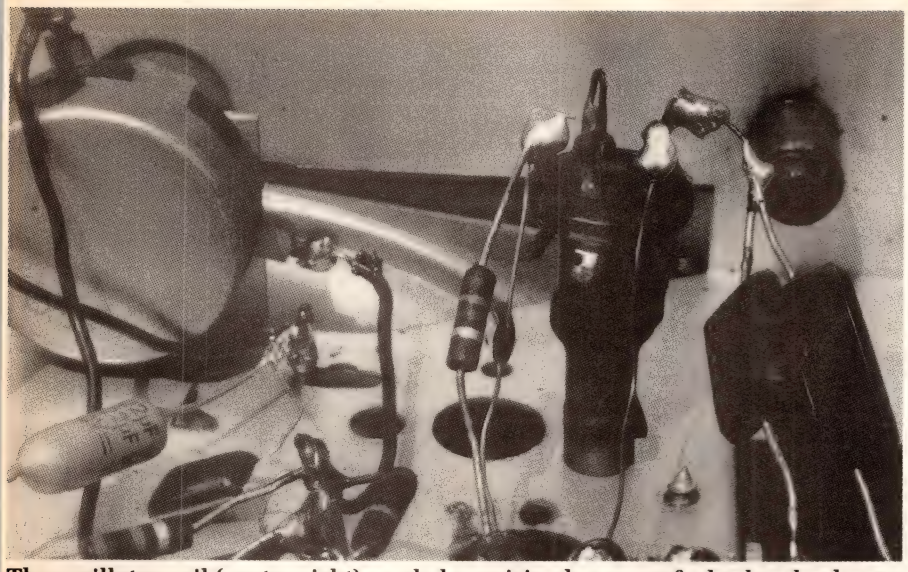
Other problems with the old Radiola were: (1) all the original paper capacitors were still in place; (2) the speaker grille cloth was a filthy, tattered mess; and (3) the dial cord was made up of four different sections of string. As the knots in the dial cord would not go around the pulleys, dial movement was restricted to about one quarter of its total length of travel. The things that some people put up with!

An examination of the oscillator coil revealed that one of its leads had broken off. If the truth be known, the wire had most likely been chewed through by a furry little rodent.

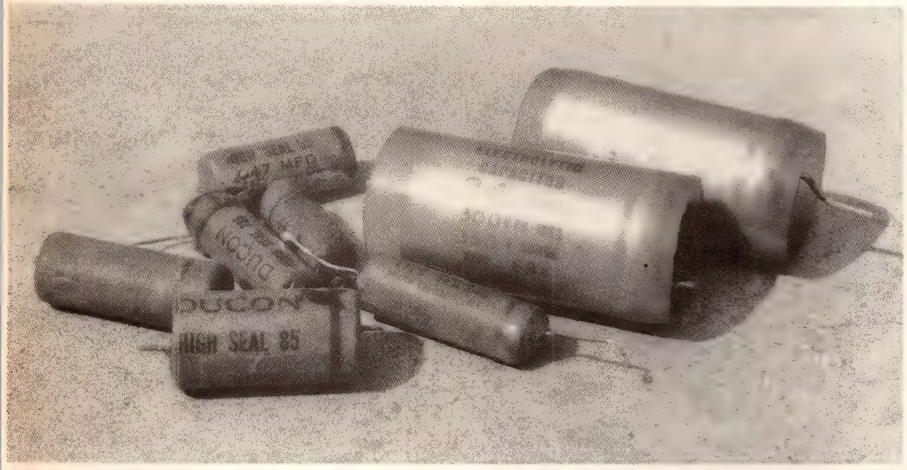
Repairing the oscillator coil was relatively simple as the broken lead protruded from the sealing compound by about two millimetres which allowed a new lead-out wire to be attached. After reinstalling the repaired oscillator coil, the set was ready for a test run, even though the paper capacitors had not been replaced at this stage.

The little Radiola fired up straight away and seemed to be in good tune, pulling in a number of stations while using only its built-in aerial.

Regardless of the fact that the set was performing well, the paper ca-



The oscillator coil (centre right) needed repairing because of a broken lead-out wire. The volume control (left) also required attention as it was noisy.



Replacing the electrolytic and paper capacitors had little effect on performance. However, leaving them in service is only asking for trouble later on.

pacitors were replaced with modern polyester types, which seemed to make little difference. Then the rot set in!

Distorted sound

After the receiver had been working for a few minutes, the sound gradually became more and more distorted. What's more, as the sound distorted, the high tension dropped from around 200V to 175V.

Leaving the set to cool off for a while produced a similar result. It worked perfectly for a few minutes, then the distortion slowly crept back. So what appeared at first to be a simple and straightforward repair had now developed into one of those mystery faults.

I suspected a faulty output valve and so a good secondhand 6BV7 was substituted for the valve that came with the receiver. I might add, at this stage, that both of these valves tested "GOOD" when checked in a valve tester.

The result was the same – the set was OK for a few minutes, then went into a slow downhill slide until the sound became quite distorted. It was time to start thinking!

Distortion is usually associated with the audio end of a receiver (but not always) and is often caused by a lack of grid bias. With this thought in mind, the back bias circuit that provides the bias voltage to the output valve was checked. The 100Ω bias resistor seemed OK and nothing could be seen that looked remotely suspect.

The grid bias on the 6BV7 output valve should be somewhere around -4V, taking into account the plate volt-

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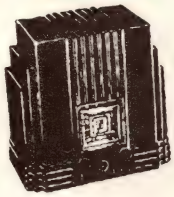

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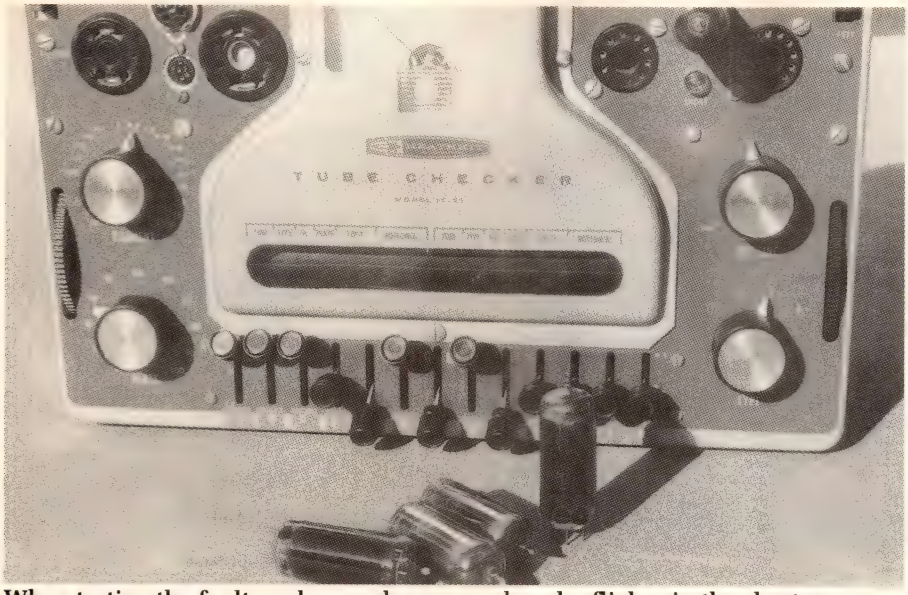
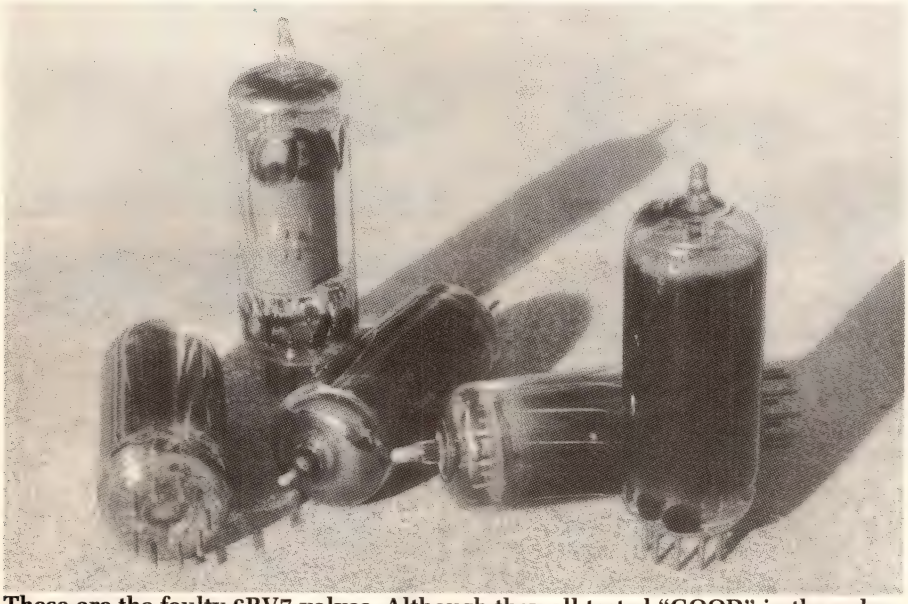


When testing the faulty valves, only one produced a flicker in the shorts indicator neon. Testing a valve in a valve tester is only half a test. The other half is to give it a thorough work-out in a working receiver.



These are the faulty 6BV7 valves. Although they all tested "GOOD" in the valve tester, they had a problem that deprived the control grid of its negative bias. They worked OK when cold but not when they became hot.

age at which the valve was operating. It seemed an appropriate time to check out the actual bias voltage.

Grid bias voltages are best checked with a digital voltmeter as these instruments have a very high input impedance, which has little or no affect on the function of the receiver. A cheap analog 2,000Ω/V meter can seriously affect both the voltage reading and the operation of the receiver under test.

The receiver was set up with two voltmeters, one to measure the high tension voltage and the other the bias voltage. The bias reading was -3V and after this reading had peaked, it went into reverse and dropped slowly until it almost reached zero. And as the bias voltage dropped, so too did the high tension voltage, due to the output valve passing increasingly more current. Distortion did not become apparent until the bias voltage decreased to about -1V.

Perhaps the bias resistor was faulty? Maybe its value decreased as it warmed up?

Not having a 100Ω resistor on hand I used a 130Ω resistor as a replacement instead. Hopefully it would increase the bias voltage to -4V and it did! But the problem remained – the reception was perfect for a few minutes and then went into a slow decline just as before.

An interesting discovery

It was at this stage that I made an interesting discovery. I replaced the original output valve in its socket while the set was still operating. The bias voltage immediately went back to -4V, stayed there for a short period, and then started dropping again. I repeated the operation with the other valve after it had cooled and the same thing happened.

The fault was in the valve – both valves, in fact! They worked OK when cold but not after they had become hot!

Out came all of the 6BV7s I had in stock. I selected a new valve and fitted it to the output socket with vastly different results. The bias voltage settled on -4V and stayed there!

It was too good an opportunity to miss out on and all the 6BV7s were checked in the receiver. Out of the 13 valves tested, six of them had the diminishing grid bias characteristic. So, in one hit, my 13 "good" 6BV7 valves were reduced to almost half that number.

The valve tester

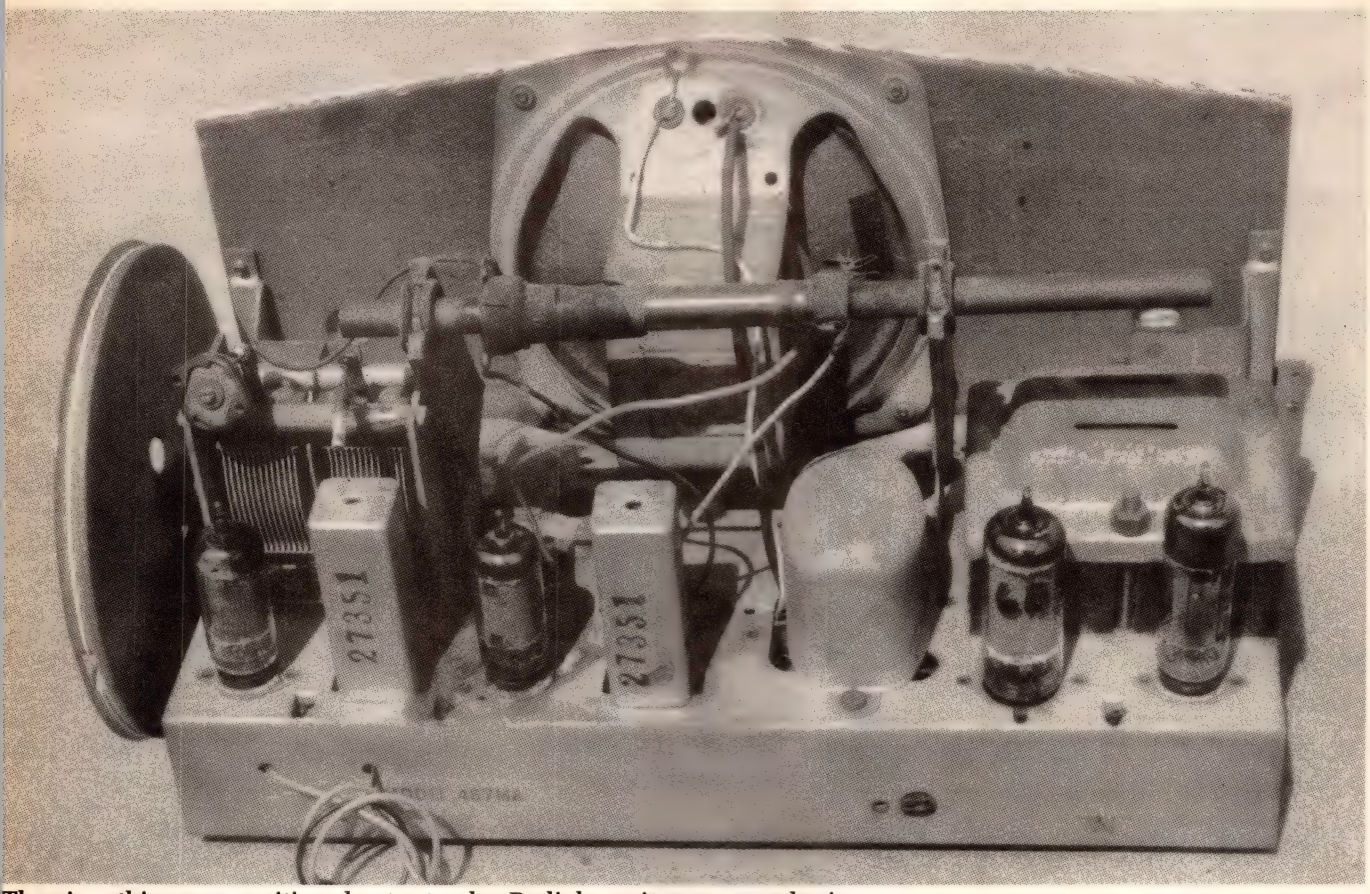
It's time for the valve tester to enter our story. I set it up to recheck all the valves that had failed in the receiver, even though they had previously checked out OK in the valve tester.

Of the six faulty valves, only one could manage to produce a flicker in the tester's shorts indicator neon. This short was on pin number eight which is the control grid. It would appear that these valves have a problem when they reach full operating temperature.

It is worth noting that the four new valves were all OK. Only the second-hand units produced the diminishing grid bias characteristic, even though most of them had emission levels comparable to new valves.

So there's something new to ponder over! Is the 6BV7 a more troublesome valve compared to other output valves? And what is the mechanism of the fault anyway?

Initially, the most likely possibility seemed to be that the valves were gassy. And a fellow enthusiast suggested that this could be aggravated



There's nothing very exciting about a 4-valve Radiola, as it was a very basic radio receiver. Note the built-in aerial mounted above the chassis. The valve line up is as follows: 6BE6, 6AU6, 6BV7 (output) and 6X4 (rectifier).

by a grid resistor that had "gone high", as they frequently did in those days.

However, these ideas had to be discounted. All resistors are routinely checked during restoration and any found to be out of tolerance are replaced. Also, I took the opportunity to try these valves in another set and they behaved identically.

That seemed to further confirm that the fault was in the valves rather than in any associated circuits. And the gas theory seemed to be ruled out by the fact that there was no violet glow in the valves, which is characteristic of this condition.

Another idea which was considered was a fault known as "silver migration". It occurred in valves with silver plated pins, the silver "migrating" across the glass, particularly between pins with a high voltage between them.

This idea was also thrown out. For one thing, the warm-up delay didn't seem to fit but, more importantly, the pins were not silver plated.

Finally, the most likely explanation would seem to be a condition known as grid emission. Apparently, this can occur when the grid becomes coated with cathode material, generally due to the heater being overrun for long periods.

So, perhaps that is the answer. But the question remains as to whether this type of valve is prone to this problem.

An unusual valve

Incidentally, for those unfamiliar with the 6BV7, it is a little unusual in that it is a duo-diode output pentode. As far as I'm concerned, it is the only one of its kind and I also suspect that it is a locally designed and manufactured valve, as it doesn't seem to be mentioned in overseas valve lists.

Actually, a duo-diode output valve is a logical type to use in a 4-valve radio. If a receiver is to have automatic gain control and diode detection, then there have to be diodes somewhere, so why not have them in the output valve?

Another mid-1950s 4-valve setup was to use valves of the duo-diode RF pentode type (6N8, 6AR7) as an IF amplifier detector and pass the resulting audio signal to a standard output valve such as a 6M5 or 6AQ5.

Looking back on the Radiola repair, perhaps the most annoying aspect was the fact that the fault was accurately diagnosed quite early as being a suspect output valve. It was ironic (read rotten luck) that the substitute valve used to check out this theory happened to have exactly the same fault!

Anyway, learning new things helps to maintain my interest in vintage radio. It is unusual faults like the one just described and their remedies that make vintage radio repairs both interesting and challenging.

When I finally learn all there is to know about valve radio servicing, then all the fun will have gone out of it for me. However, as that time seems a long way off, I'm sure that vintage radio will continue to hold my interest for many years to come. **SC**

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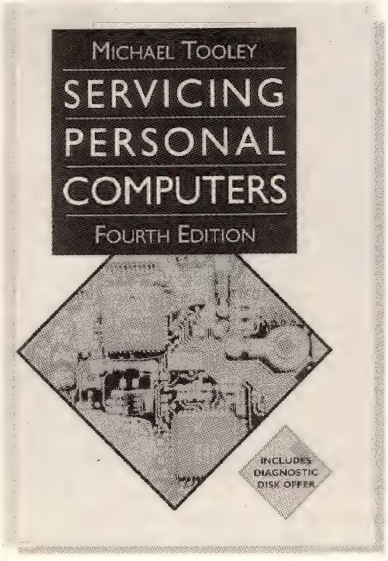
BOOKSHELF

Servicing Personal Computers

Servicing Personal Computers, by Michael Tooley, B. A. Published 1994 by Newnes, distributed by Butterworth-Heinemann Australia. Hard covers, 387 pages, 240 x 170mm, ISBN 0-750-61757-8. Price $68.95.



In this age of personal computers (or PCs as they have become known), many users, while not necessarily wanting to repair their own, will be keen to have a better understanding of the "innards" of their computer. This book will certainly enlighten them.

The first of the eight chapters in this book begins with an introduction to microprocessors, detailing the different modules that make up a typical computer. It then goes on to discuss the evolution of the home computer, beginning with the release of the 4004, a 4-bit processor, by Intel in 1971. Subsequent processors of note are then listed, through to the Intel 80486 and Motorola 68030.

A couple of pages are then devoted to a discourse on programming, mentioning both assembly and high-level languages.

RAM (Random Access Memory) is then covered in some detail, after which brief details are given of keyboards, serial I/O (input/output), RS-232 interfaces, raster scan displays and finally SCSI (Small Computer Systems Interface) controllers.

The second chapter covers the selection of a suitable workshop site and the consideration that should be given to workbenches, storage, lighting, security and safety. A list of the basic tools required for competent service is given along with an extended list, although I believe that every workshop should consider the extended list to be the minimum.

Tooley then gives a list of the minimum test equipment which would be required to set up a workshop with adequate facilities, then an extended list which would add many dollars to the cost.

A short discussion follows on the methods of using multimeters, oscilloscopes, logic probes, logic pulsers and logic analysers.

Chapter three covers general fault diagnosis at three levels: basic, intermediate and advanced. Basic level skills are defined as being able to locate blown fuses, faulty cables or failed hard disc drives. Intermediate skills would allow the technician to locate intermittent connectors, faulty discrete components or a failed processor. Those possessing advanced skills would be able to locate intermittent problems, temperature faults and bus conflicts.

The balance of the chapter is devoted to fault finding techniques for the CPU (Central Processing Unit), video circuits and RS-232 interface.

Chapter four introduces the reader to tape and disc drives. Some of this material is rather antiquated (tape recorders using Kansas City recording standards) but if one is to make a living servicing computers, this knowledge could be useful.

The evolution of floppy discs is traced from the 8-inch though the 5.25-inch to the current 3.5-inch types. As well, technical information is listed for a number of popular drives. The author then gives a description of the original IBM 8-inch format, which is still the basis for formatting current floppy discs. Details of several floppy disc controllers are included as well as methods of fault diagnosis for floppy disc drives.

The balance of this chapter is devoted to hard disc drives, including formatting, partitioning and the use of the DOS FDISK program.

Chapter five is devoted to printers, which, being mechanical devices, require routine maintenance to keep them operating at peak performance. The author introduces dot matrix printers and explains how the print head actually prints a character, then lists the sensing mechanisms needed to keep track of the head position. A two-page table of dot matrix printer faults and repair procedures follows.

A few lines are then devoted to the operation of laser printers and details of the self-test procedures which should be carried out to determine the cause of any failure. Routine maintenance and a one-page fault finding guide complete this chapter.

"Displays" is the title for chapter six, which surprisingly only covers raster scan displays. A raster scan is one that uses a cathode ray tube and deflection coils to move the electron beam across the face of the tube, as

distinct from LCD and other newer solid state displays. Tooley starts by explaining the requirements for a video monitor and the reasons why a normal TV set is unsatisfactory. This is followed up with a block diagram of a monochrome monitor. He continues with details of the colour shadow mask tube and the procedure for making colour adjustments. The chapter concludes with two pages of display faults and their cures.

Chapter seven covers servicing of 68000 based microcomputers. Computers that use this chip include the Apple Macintosh, the Sinclair QL, the Atari ST and the Commodore Amiga. The section devoted to each of these products includes a block diagram of the computer, a memory map and details of upgrades or modifications recommended by the respective manufacturers.

The final chapter is about servicing the IBM and compatible PCs. It starts with a brief description of the original IBM XT and works through to the PS/2 80. While the chapter mainly covers IBM machines, the Amstrad PC1640 block diagram and other details are included.

Details and pin connections of the 8087 maths co-processor, the 8273A DMA (Direct Memory Access) controller and the 8253 (PIT) programmable interval timer, as well as several other important chips, are given, along with a Qbasic program to test whether a co-processor is fitted to the PC board.

The memory terminology for PCs is explained as well as the function of the CMOS RAM and the BIOS (Basic Input Output System) ROM. The chapter continues with a description of the evolution of the PC bus and concludes with details of the video modes and colours available with each mode.

A reference section of some 40 pages concludes this book, containing information on commonly used symbols, RAM data, character sets, power on self test and seven other useful summaries.

To conclude, a very interesting book which covers all aspects of PCs, from basics to quite advanced fault finding. Our copy came from Butterworth-Heinemann Australia, PO Box 5577, West Chatswood, NSW 2067. Copies can be obtained from SILICON CHIP. The ordering details are shown in the SILICON CHIP Bookshop advertisement in this issue. **SC**

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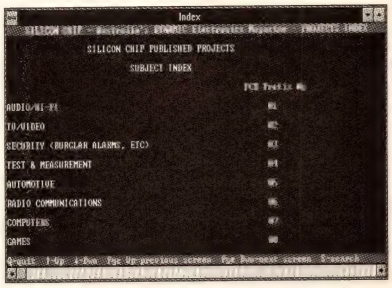

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$9

ARGON ION LASERS

US made Argon Ion laser heads with connecting leads and matching 110V AC power supplies. Multiline units in good condition that produce 40mW + outputs:

$2200 ea.

MASTHEAD AMPLIFIER SPECIAL

High performance low noise masthead amplifier covers VHF, FM & UHF and is based on a MAR-6 IC. Includes two PCBs, all on-board components. For a limited time we will also include a suitable plugpack to power the amplifier from mains for a total price of:

$25

SPRING REVERB

Large studio quality, 6-spring reverberation units. Overall dimensions 425 x 110 x 33mm, input Z = 190Ω, output Z = 2.6kΩ, recommended AC drive = 6.5 mA.

SPECIAL INTRODUCTORY PRICE: $60

FAX LENSES

Small precision lens assembly as used in fax machines. Cylindrical construction: 32mm long x 25mm diam. Contains 4 high quality lenses.

$5.50

TOMINON HIGH POWER LENS

These 230mm (1:4.5) lens have never been used. They contain six coated glass lenses, symmetric, housed in a black aluminium case. Scale range is from 1:10 through to 1:1 to 10:1. Applications include high quality image projection at macro scales and portrait photography in large formats.

$45

PROJECTION LENS

Brand new, precision angled projection lens. Overall size is 210 x 136mm. High-impact lexan housing with focal length adjustment lever. When disassembled, this lens assembly yields three 4" diameter lenses (concave, convex-concave, convex-convex). Very limited quantity:

$35

LASER POINTER PEN

A pen style laser rated at 5mW/670nm. Brighter than most pens due to the use of a high quality lens. Has a metal body with a tactile switch and operates from 2 AA batteries (not included). Also suitable for medical uses:

$75

MINI PHONO

This brand new unit was designed to play small records which are no longer available. The compact self-contained unit (140 x 83 x 57mm) is housed in a plastic case and includes a motor, speaker and amplifier. Great for a simple workbench audio amplifier that is powered from 2 AA batteries (not included):

$8

AIR COOLED ARGONS

Used Argon-Ion heads with 30-100mW output in the blue/green spectrum. Priced at around $350 for the "head" only, power supply circuit and information supplied.

LIMITED SUPPLY.

LIGHT MOTION DETECTORS

Small PCB assembly based on a ULN2232 IC. This device has a built in light detector, filters, timer, narrow angle lens, and even a siren driver circuit that can drive an external speaker. Will detect humans crossing a narrow corridor at distances up to 3 metres. Much higher ranges are possible if the detector is illuminated by a remote visible or IR light source. Can be used at very low light levels and even in total darkness: with IR LED. Full information provided. The IC only is worth $16! OUR SPECIAL PRICE FOR THE ASSEMBLY IS:

$5 ea. or 5 for $20

LOW COST PIR KIT

This PIR movement detector is based on single LSI IC design and features simple construction. Even the lens assembly snaps onto the PCB. Has every imaginable feature: Negligible power consumption, optional/adjustable daylight disable with LDR light detector supplied, 10m range, variable alarm time, disable input, 10A MOSFET output, 10-20V DC operation. Fits into the smallest zippy box! A complete PCB and all on-board components kit is available for only:

$18

40mW IR LASER DIODES

New famous brand 40mW-830nm IR laser diodes, suit medical and other applications:

$60 ea.

Constant current driver kit to suit: $10.

AC MOTOR

Small but very powerful GEARED AC motor. 1 RPM/60Hz/24V/5 watt. We supply a circuit diagram that shows how to power this motor from 12V DC: variable speed/full power (bridge output). Bargain priced: $9 PCB and all on-board components kit for the 12V driver kit: $8

DOT MATRIX LCDs

Brand new Hitachi LM215 400 x 128 dot matrix Liquid Crystal Display in an attractive housing. These have driver ICs fitted but require an external controller. Effective display size is 65 x 235mm. Available at less than 10% of their real value:

$25 ea. or 3 for $60

POWER SUPPLIES

Used but very clean non-standard size computer power supplies, enclosed in metal casing with perforated ends for air circulation, built in fan, IEC input connector and OFF-ON switch, "flying" DC output leads, overall dimensions: 87 x 130 x 328mm, 110-220V input (were used on Australian mains) +5V/8A, +12V/3A, and -12V/0.25A DC outputs.

BARGAIN REDUCED PRICED: $15 ea. or 4 for $50

OPTICS

USSR LENS 100mm - f2 Pentax screw mount thread, as used for night viewers, has focus adj. but no iris adj.: $60. **USSR LENS** 58mm - f2 Pentax screw mount lens as used for cameras, has focus and iris adj.: $60. **BEAM SPLITTER** for 633nm: $45. **PRECISION FRONT SURFACE ALUMINIUM MIRRORS** 200 x 15 x 3mm: $3; 50 x 72 x 3mm: $3. **LINE GENERATING OPTIC:** makes a line out of a laser beam: $5. **LASER DIODE COLLIMATING LENS:** $4. **PORRO 90 deg. PRISM:** makes a rainbow from white light: $10. **ARGON MIRRORS:** high reflector and output coupler used to make a Argon tube: $50.

27MHz TRANSMITTERS

New transmitters are assembled (PCB assy.) and tested. They are Xtal locked on 26.995 MHz and were originally

intended for transmitting digital information. Their discrete component design employs many components, including 5 transistors and 8 inductors: circuit provided. A heatsink is provided for the output device. Power output depends on supply voltage and varies from 100mW to a few watts, when operated from 3-12V DC. These are sold for parts/experimentation/educational purposes, and should not be connected to an antenna as licensing may be required:

$7 ea. or 4 for $20

VISIBLE LASER DIODE KIT

A 5mW/660nm visible laser diode (very bright!!) plus a collimating lens, plus a housing, plus an APC driver kit (Sept. 94 EA)

UNBELIEVABLE PRICE: $40

Housing plus battery holder plus switch $5 extra.

LOW COST 1-2 CHANNEL UHF REMOTE CONTROL

A 304MHz UHF remote control with over 1/2 million code combinations which also makes provision for a second channel expansion. The low cost design features keyring size transmitter kits that include a case and battery, and a PCB and components kit for the receiver that has 2A relay contact outputs!.

1ch Tx kit: $10, 2ch Tx kit: $16, 1ch Rx kit: $20

Extra components for 2 channel Rx operation (extra decoder IC and relay): $6.

3-STAGE NIGHT VIEWER KIT

See SC Sept. 94. We have accumulated a good number of 40mm three stage fibre optically coupled three-stage image intensifiers that have minor blemishes. The three tubes are supplied already bonded together: extremely high gain!! We can supply this three-stage tube plus a power supply kit plus a lens and an eyepiece for a total cost of:

$250

That is an almost complete starlight night viewer kit!
We can also supply the full SC September 94 magazine: $5.

VISIBLE LASER DIODE MODULES

Industrial quality 5mW/670nm Laser diode modules. Overall dimensions: 11mm diameter by 40mm long. Have APC driver built in and need approximately 50mA from 3-6V supply.

$60

VIDEO TRANSMITTERS

Low power PAL standard UHF TV transmitters. Have audio and video inputs with adjustable levels, a power switch, and a power input socket: 10-14V DC/10mA operation. Enclosed in a small metal box with an attached telescopic antenna. Range is up to 10m with the telescopic antenna supplied, but can be increased to approximately 30m by the use of a small directional UHF antenna.

INCREDIBLE PRICING: $25

12V FANS

Brand new 80mm 12V-1.6W DC fans. These are IC controlled and have four different approval stamps:

$10 ea. or 5 for $40

TDA ICs/TRANSFORMERS

We have a limited stock of some 20 Watt TDA1520 hifi quality monolythic power amplifier ICs: less than 0.01% THD and TIM distortion, at 10W RMS output! With the transformer we supply we guarantee an output of greater than 20W RMS per channel into an 8-ohm load, with both channels driven. We supply a far overrated 240V-28V/80W transformer, two TDA1520 ICs, and two suitable PCBs which also include an optional preamplifier section (only one additional IC), and a circuit and layout diagram. The combination can be used as a high quality hifi Stereo/Guitar/PA amplifier. Only a handful of additional components are required to complete this excellent stereo/twin amplifier! Incredible pricing:

$25

For one 240V-28V (80W!) transformer, two TDA1520 monolythic hifi amplifier ICs, two PCBs to suit, circuit diagram/layout. Some additional components and a heatsink are required.

TWO STEPPER MOTORS PLUS A DRIVER KIT

This kit will drive two stepper motors: 4, 5, 6 or 8-wire stepper motors from an IBM computer parallel port. Motors require separate power supply. A detailed manual on the COMPUTER CONTROL OF MOTORS plus circuit diagrams/descriptions are provided. We also provide the necessary software on a 5.25" disc. Great "low cost" educational kit. We provide the kit, manual, disc, plus TWO 5V/6 WIRE/7.5 Deg. STEPPER MOTORS FOR A SPECIAL PRICE OF:

$42

HELIUM-NEON LASER BARGAIN

Helium Neon 633nm red laser tubes that were removed from new and near new equipment. These are suitable for light shows. Output power is in the range of 2.5-7.5mW. With each of the tubes we will include our 12V Universal Laser power supply Mk.IV (no problems with our new transformers). **ON SPECIAL** at a reduced price of: **$80** for a 2.5-4.0mW tube and supply. **$130** for a 4.0-7.5mW tube and supply.

12V-2.5 WATT SOLAR PANEL KITS

These US made amorphous glass solar panels only need terminating and weather proofing. We provide terminating clips and a slightly larger sheet of glass. The terminated panel is glued to the backing glass, around the edges only. To make the final weatherproof panel look very attractive some inexpensive plastic "L" angle could also be glued to the edges with some silicone. Very easy to make. Dimensions: 305 x 228mm, Vo-c: 18-20V, Is-c: 250mA. SPECIAL REDUCED PRICE:

$20 ea. or 4 for $60

Each panel is provided with a sheet of backing glass, terminating clips, an isolating diode and the instructions. A very efficient switching regulator kit is available; suits 12-24V batteries, 0.1-16A panels, $27. Also available is a simple and efficient shunt regulator kit, $5.

SOLID STATE "PELTIER EFFECT" DEVICES

These can be used to make a solid state thermoelectric cooler-heater. Basic information supplied:

12V-3.4A PELTIER: $25
12V-4.5A PELTIER: $35

We can also provide two thermal cutout switches, and a 12V DC fan to suit either of the above, for an additional price of $10.

VEHICLE COMPUTERS

Originally designed for bicycles but these suit any moving vehicle that has a rotating wheel! A nine function computer with speed, average speed, maximum speed, distance, odometer, timer, scan, freeze frame memory and a clock. Its microprocessor based circuitry can be adapted to work with almost any wheel diameter. Simply divide the wheel diameter in millimetres by 6.8232 and program the resultant figure into the computer.

$29.90

MORE KITS

MODEL TRAIN CONTROLLER: run two trains on one track without any collisions, uses kit IR LEDs/transistors for detectors (supplied), doubles up as a crossing controller with flashing crossing LEDs. Incredible pricing: $20. **TRAIN SOUND GENERATOR:** can be used in conjunction with the controller to produce crossing and other sounds, when a train is on a particular part of a track: $12. **4 CHANNEL UHF REMOTE CONTROL KIT:** two transmitters and one receiver: $96. **GARAGE-DOOR-GATE REMOTE CONTROL KIT:** SC Dec. 93. Tx $18, Rx $79. **1.5-9V CONVERTER KIT:** $6 ea. or 3 for $15. **LASER BEAM COMMUNICATOR KIT:** Tx, Rx, plus IR Laser: $60. **ELECTRIC FENCE KIT:** PCB and components, includes prewound transformer: $40. **PLASMA BALL KIT:** PCB and components kit, needs any bulb: ON SPECIAL $20. **BRAKE LIGHT INDICATOR KIT:** 60 LEDs, two PCBs and 10 Rs, makes for a very bright 600mm long high intensity red display: ON SPECIAL $25. **FM TRANSMITTER KIT - MKII:** high quality - high stability, suit radiomicrophones and instruments, 9V operation, the kit includes a PCB and all the on-board components, an electret microphone, and a 9V battery clip: $11. **FM TRANSMITTER KIT - MKI:** this complete transmitter kit (miniature microphone included) is the size of an "AA" battery and it is powered by a single "AA" battery. We use a two "AA" battery holder (provided) for the case, and a battery clip (shorted) for the switch. Estimated battery life is over 500 hours!!: $11. **PROTECT ANYTHING ALARM KIT:** EA May 93, ON SPECIAL, PCB and all on-board components kit: $20. **ELECTRIC FENCE KIT:** SC Apr. 94. ON SPECIAL: $28. **ELECTRONIC KEY KIT:** EA July 92, 2 keys plus one receiver, ON SPECIAL: $30.

MORE ITEMS

PRINTER MECHANISMS: brand new Epson dot matrix printer mechanisms, overall dimensions are 150 x 105 x 70mm: $12. **SWITCHED MODE POWER SUPPLIES:** mains in (240V), new assembled units with 12V-4A and 5V-4A DC outputs: $32. **INDUCTIVE PROXIMITY SWITCHES:** detect ferrous and nonferrous metals at close proximity, AC or DC powered types, three wire connection for connecting into circuitry: two for the supply, and one for switching the load, these also make excellent sensors for rotating shafts etc.: $22 ea. or 6 for $100. **IEC EXTENSION LEADS:** 2m long, IEC plug at one end, IEC socket at other end: $5. **MOTOR SPECIAL:** type M9: 12V, I No load = 0.52A-15,800 RPM at 12V, 36mm diam.-67mm long: $5; type M14: made for slot cars, 4-8V, I No load = 0.84A at 6V, at max efficiency I = 5.7A-7500 RPM, 30mm diam.-57mm long: $5. **EPROMS:** 27C512, 512K (64K x 8), 150nS Access CMOS EPROMS, removed from new equipment, need to be erased, guaranteed: $4. **EHT POWER SUPPLY:** out of new laser printers, deliver -600V, -7.5kV and +7kV when powered from a 24V-800mA DC supply, enclosed in a plastic case: $16. **MAINS CONTACTOR RELAY:** has a 24V 250-ohm relay coil, and four separate SPST switch outputs, 2 x 10A and 2 x 20A, new Omron brand, mounting bracket and spade connectors provided: CLEARANCE @ $5 ea. **SUPERCAPS:** 0.047F/5.5V capacitors: 5 for $2. **PCB MOUNTED SWITCHES:** 90 deg. 3A-250V, SPDT: 4 for $2. **3" CONE TWEETERS:** sealed back dynamic 8ohm tweeters: $5 ea. **WELLER SOLDERING IRON TIPS:** new tips Weller stations and mains operated Weller irons, mixed popular types, specify mains or station type: 5 for $10. **LCD CHARACTER DISPLAYS:** standard 16 x 1 displays, 5V operation: $20.

COMPONENTS

HIGH INTENSITY RED LEDs: 550-1000mCd @ 20mA, 100mA max, 5mm housing: 10 for $4, or 100 for $30. **BLUE LEDs:** 5mm: $2.50. **ELECTRET MICROPHONE INSERTS:** high output standard size omnidirectional: 10 for $8. Also some high quality unidirectional electrets that were removed from new equipment: $3 ea. **ULTRASONIC TRANSDUCERS:** high quality Murata 40kHz transmitter and receiver transducers: $4 pr., 40kHz Xtal to suit: $2. **3.57MHz XTALS:** 10 for $6. **OP27 OPERATIONAL AMPLIFIERS:** super operational amplifier ICs!: $3 ea. **ENCODER DECODER ICs:** as used in many projects, SC Dec. 92, EA Mar. 93 and 94, AX526/7/8 ICs: $3.50 ea. UHF Module to suit: $15. **DYNAMIC MICROPHONE INSERTS:** unidirectional low impedance inserts: $4 ea. **HIGH VOLTAGE DISC CERAMICS:** 680pF-3kV: 20 for $4, 0.015µF-3kV: $2 ea. **HIGH VOLTAGE DIODES:** all are very fast!, 1kV-1A: 10 for $5, 8kV-20mA: $1.50, 16kV-20mA: $2 ea. **GAS FILLED ARRESTORS:** 10 for $3. **THERMISTORS:** 2.5ohm NTC: 10 for $2. **TRIACS:** 600V-60A, CLEARANCE: $3 ea. **COMPRESSION TRIMMER:** 250pF, mica dielectric, new but may be slightly soiled, ceramic base: $1 ea.

MORE IR COMPONENTS

880nm/12 deg./30mW @ 100mA IR LEDs: 10 for $9
880nm/60 deg./30mW @ 100mA IR LEDs: 10 for $9
940nm/12 deg./16mW @ 100mA IR LEDs: 10 for $5
IR DETECTOR PIN DIODE: 10 for $10
5mW/780nm laser diode (LTO26): $16 ea.

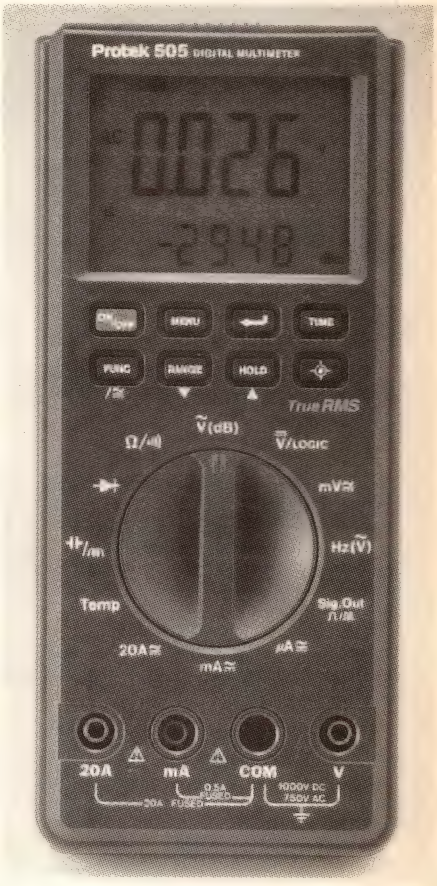
MORE ITEMS AND KITS

Poll our (02) 579 3955 or (02) 579 3983 fax numbers for instructions on how to obtain our Item and Kit lists. MANY MORE ITEMS AND KITS THAN ARE LISTED HERE!! You can also ask for a copy of these to be sent out with your next order.

PRODUCT SHOWCASE

Protek 505 digital multimeter has dual display

This Protek 505 digital multimeter has a large dual digital display plus bargraph, true RMS readings, memory storage and 4000 count resolution. In addition, it will measure temperature, frequency, capacitance and inductance.



While all multimeters will perform voltage, current, resistance and diode tests, there are not many which can also measure temperature, frequency, capacitance, inductance, logic levels and dBm values. You can also measure time period for stop watch or alarm functions and store measured values in up to nine memory locations. The Protek 505 also includes a signal generator with three output frequencies (2048, 4096 and 8192Hz square wave). Naturally it is autoranging and this can be overridden if required.

The liquid crystal display (LCD) has a dual digital readout and bargraph plus numerous annunciators. This dual readout allows two measurements to be displayed and measured at once. For example, when measuring frequency, the display will show the reading in Hz on the main display and the value of AC volts on the secondary scale. When the time display is selected, this is shown on the secondary scale with the measured value of volts, current, temperature or resistance on the main digits.

There is no skimping on the size of the display either. The main and secondary display digits are 19mm and 9mm high respectively, while the bargraph displays from 0 to 40 with 21 active segments. The word "active" is used because the display appears to have 37 segments. However, 16 of these are doubled up so that they are "lit" together. Knowing this is important when attempting to read the bargraph value. The bargraph is useful for seeing the trend of value changes which can be too fast for the digital display to update. The display can be backlit for use in dark locations.

Most of the functions available can be manipulated to provide maximum, minimum, average and relative readings. These are accessed using the menu key. Once this key has been pressed though, there is no way out; you are stuck with selecting either Max, Min, Avg, Rel or Keep On unless the power is switched off. We would prefer to have an Out selection which restores the meter to provide normal readings.

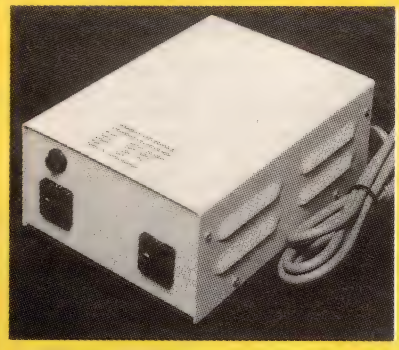
The relative (Rel) display is useful when there is a fixed offset in the measurement. This can be subtracted so that only the change is displayed. Relative readings can also be displayed as a percentage change from the reference value.

A hold feature freezes the display at any time so that no further changes in the reading take place. Readings can also be placed in memory for a more permanent storage. There are 9 memories available, labelled 1-9. The "0" memory location is inactive and cannot be used for storage. It can be recalled but it only shows 0000. The handbook indicates that this memory location is not useable, however, they also claim that there are 10 memory locations! The memory locations are not erased when the meter turns off in the auto power off mode.

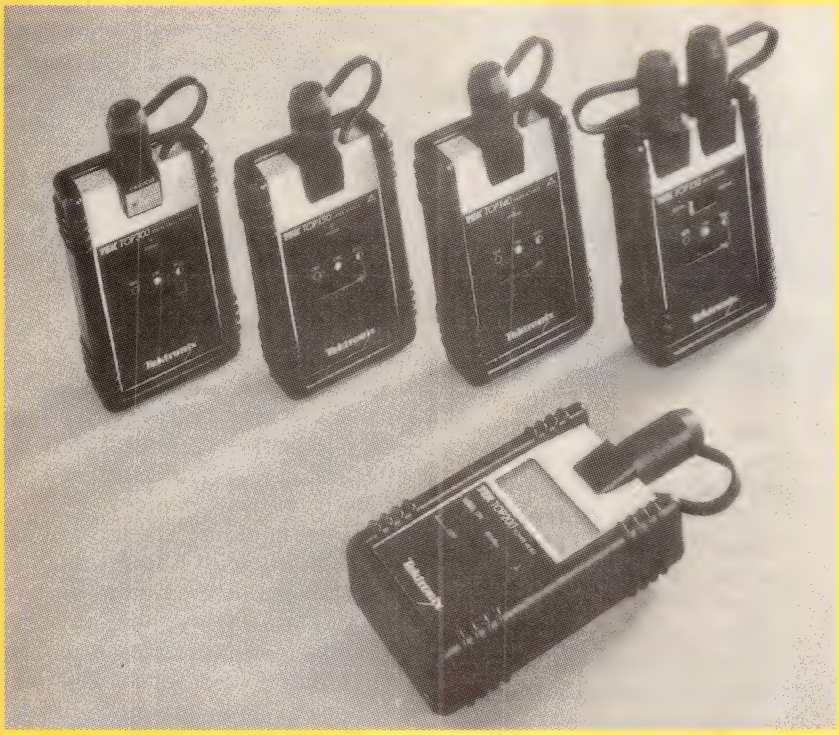
To prevent the meter from switching off after 30 minutes of inactivity, a "keep on " facility is available which disables the automatic power off. Naturally, the meter can be turned on

STEPDOWN TRANSFORMERS

60VA to 3KVA encased toroids



Harbuch Electronics Pty Ltd
9/40 Leighton Pl. HORNSBY 2077
Ph (02) 476-5854 Fx (02) 476-3231



Optical light sources & power meter

Tektronix has introduced a new line of handheld optical test products that include the TOP130, TOP140 and TOP150 optical light sources, the TOP200 power meter and the TOP300 visual fault finder. The TOP130 emits at 850/1300nm and is suitable for testing multimode cable used in LANs and WANs; the TOP140 laser source emits at 1310nm and the TOP150 laser source emits at 1550nm. Models TOP140 and TOP150 are used for testing single mode cables in Telco and CATV networks.

All the light sources feature a universal connector interface for easy upgrade and cleaning. Battery life is claimed to be over 100 hours with standard alkaline batteries.

A companion product to the Tektronix optical light sources is the TOP200 optical power meter. It is a low-cost, palm-size unit that makes basic optical power measurements in either dB or dBm, calibrated at 850nm, 1300nm and 1550nm. This power meter provides .01dB resolution and allows the user to store reference values for each wavelength independently.

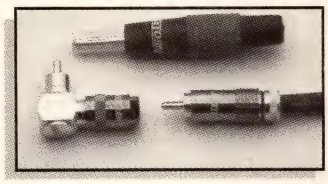
For further information, contact Tektronix Australia Pty Ltd, 80 Waterloo Road, North Ryde, NSW 2113. Phone (02) 887 7066.

and off at will using a separate push-button switch. The handbook recommends switching off manually rather than waiting for the automatic power off feature. This would be a good idea since battery life is only about 60 hours with a carbon zinc battery. Fortunately, a low battery warning indicator is included so that you will know when to replace it and a separate battery compartment is provided, allowing easy access.

Diode readings display the forward voltage measured between anode and cathode on the secondary display. The main display shows either SHrt (short), OPEn or Good. These are supposed to tell you whether the diode is operating correctly. We found that good Schottky and high speed diodes gave a "short" indication because their forward voltage was below 0.5V. The diode test provides up to 4V and so LEDs can be tested. The LED will light up and an open indication will be given because the forward voltage of the LED is greater than 1V. Some discretion must therefore be used when interpreting the short and open indications.

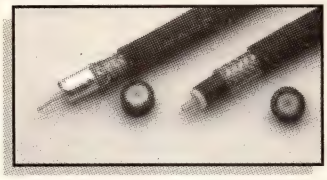
NEOTECH

CONNECTORS



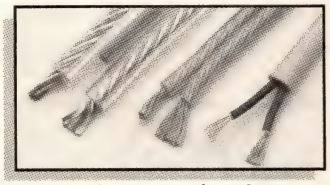
- Highest quality metal body with teflon insulation
- 24K gold plated pins, solder and screw terminations
- Improved "split" pin
- Locking RCA plugs, right angle types also available
- Accepts cables with 6mm to 9mm diameters

INTERCONNECT CABLE



- Perfect imaging
- 99% pure OFC copper conductors for improved signal transfer characteristics
- Super flexible and easy stripping PVC jacket
- All models are double shielded with either Mylar or Carbon conductive PVC
- Ultra low capacitance
- Rejects EMI and RFI noises

SPEAKER CABLE



- Dynamic reproduction
- 99% pure OFC copper conductors for improved signal transfers
- Multiple configurations: round multicore, flat multi & standard figure "8" style

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Video magnifier uses CCD camera

This 1/2-inch colour CCD high resolution video camera/microscope provides 10x, 20x and 40x magnification with greater than 450 lines horizontal resolution. The SVC-228 offers advantages over magnifying glasses and other optical inspection devices. Several or groups of people can simultaneously observe the image for discussion; images may be recorded on a VCR or, by using an interface card, stored in a personal computer for documentation, manipulation, measurement or printout.

The SVC-228 comprises a main unit which houses the power supply and interface circuitry and connects via a 2-metre cable to the camera head. Optional lenses provide a choice of magnification. Also available is an adjustable stand with lamps for illumination. Applications include assembly and inspection of mechanical parts, components, surface mount devices, PC boards, contacts, connectors, measurement, quality control and verification.

For further information contact Allthings Sales & Services, PO Box 25, Northlands, WA 6021. Phone (09) 349 9413 or fax (09) 344 5905.

Temperature sensing must be done using a "K" type thermocouple, which is available as an accessory. The probe can measure temperature from -20°C to 1200°C which is then shown on the main display. The secondary display shows the Fahrenheit value. With no probe connected, the readout will show ambient temperature and is useful for finding out why you feel cold (we reviewed this meter in the middle of winter!).

While the meter can read inductance, it is restricted to values above 10mH which is a relatively large value in practice. Most inductances used in RF and switchmode supplies are much smaller than this. Note also that if the Q is less than 10 or the coil resistance is greater than 100Ω, then inaccuracies will result.

The capacitance measurement range is better, at up to 100µF with a .01µF resolution. This means that you can measure 10nF and larger up to 99µF. We would have preferred to be able to measure much smaller values than 10nF (.01µF).

The frequency meter mode can be used for measurements from 1Hz up to 9999MHz with 4-digit resolution. The input signal for the frequency mode is a minimum of 1.5V RMS (4.24V p-p). This is fine for CMOS and TTL circuits but most analog and RF circuits will need a preamp/buffer for meaningful measurements.

Incidentally, the meter incorporates a logic level range which indicates a logic Hi and logic Lo on the main display. The in-between voltage where the logic is indeterminate is indicated by a "....". The logic voltage is set for TTL levels and so it is suitable for high speed CMOS as well.

Three output frequencies are available from the meter. These are at 8192, 4096 and 2048Hz with a 4V p-p minimum output. The source impedance is 1.5kΩ so that it can drive logic circuitry. Interestingly enough, the signal swings between -0.7V and +3.3V. This indicates that the internal signal generator must be AC coupled with a diode clamp to prevent the negative excursion going beyond one diode drop.

Timer counting is available for up to 10 hours with a count rate of one second. You can count up from zero to 9hr 59min 59sec and the alarm will sound one second after this maximum count has been reached. The counter is presettable to any time within this range. Counting down is also possible. In this case, however, the alarm sounds one second after 0.00.00 has been reached.

AC voltage measurement is true RMS. This means that the correct reading is obtained for waveforms other than pure sinewaves. On a normal meter without true RMS readings, the display is calibrated to give a correct RMS reading only for sinewaves. With true RMS, the reading is essentially correct for other types of waves. For example, the additional error in reading compared to the sinewave for square and triangle waves is 0.2% and 0.3% respectively. For crest factors up to 2, the additional error is 0.5%. For accuracy details, see the latter part of this review.

Also on the AC voltage range is displayed a dBm reading on the secondary display. A reading of 0dBm means that the voltage is 0.7746V. This corresponds to 1mW into a 600Ω load and all dBm values displayed are referenced to this level.

Continuity measurements are available with or without a tone. With tone selected the meter will register an OPEn condition above 100Ω and will show a short otherwise. Without the tone selected, the meter only shows the value in ohms.

Accuracy

The Protek 505 has ±0.3% +2 digits

Audio Lab **R.S.K. Electronics Pty. Ltd.**

Complete Audio Lab kit with PCBs, 1% resistors, PTH screened PCBs, IC sockets, boot Eprom, screen printed case, 8K RAM, 8031 processor and all ICs.

Includes calibration and Audio Lab V5.1 software $330 inc. tax.

10 VAC 1A plugpack plus socket $18. Processor test kit $15.
2-Metre serial cable $9. Freight $9.

Fully assembled & calibrated complete with plugpack (1-year warranty) $450

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accuracy for the 400mV DC range. For the 4V to 1000V ranges, the accuracy is ±0.5% +2 digits. AC voltage accuracy is ±1% +3 digits for the 400mVAC range from 50Hz to 1kHz. The 4VAC to 750VAC ranges are ±1.5% +5 digits accuracy from 50Hz to 100Hz for the 4VAC range and up to 500Hz for the remaining ranges.

Resistance accuracy is ±0.5% +2 digits up to 400kΩ and 1% +2 digits for ranges above this. DC current accuracy is ±1% +2 digits and AC current is ±1.5% +3 digits from 50Hz to 100Hz. This rises to ±3% +5 digits from 100Hz to 1kHz.

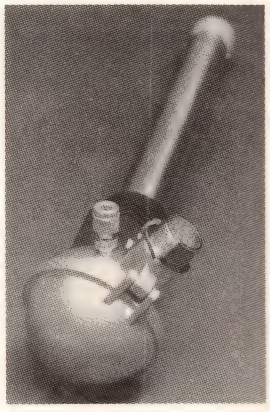
Frequency accuracy is ±0.01% +2 digits. Temperature accuracy is ±3% +5 digits from -20°C to 10°C . It is ±3% +3 digits from 10°C to 350°C . Capacitance accuracy is ±3% +5 digits and inductance accuracy is the same for values up to 20H.

The meter is fully protected from over-voltage and over-current using fuses and a PTC thermistor. A spare 0.5A fuse is included inside the case. However, there is no spare 20A fast blow type included.

The meter is supplied in a vinyl case which also holds the probe leads and handbook. The probes have two screw-on alligator clips for the probe tips which are a worthwhile inclusion.

In short, the Protek 505 is a lot of meter for the money. With true RMS measurement, dual display, bargraph and a host of measurement functions, it will be a popular unit. It is priced at $229 including tax and is available from Altronics in Perth or from their dealers Australia wide. Phone 1 800 999 007.

Fast response oxygen probe



Novatech Controls has developed a fast responding oxygen sensing probe for flue gas, furnace and kiln applications.

The zirconia sensor in this device has a response time in the millisecond region but is extended by the time taken to introduce the gas sample from the process to the sensor. The total speed of the response time can be critical, particularly for use in automatic combustion trim systems.

The Novatech development, which was the result of extensive wind tunnel testing, provides users with a probe which will respond to changes in the oxygen level of the sample within four seconds. It has an optional 10 micron particulate filter for flues with fly ash or other material which can block up sensing ports.

The benefit to users of fast responding flue gas oxygen sensing probes is improved trim control of combustion air/fuel ratio. This means savings in fuel. In some critical cases where process measurement lag cannot be tolerated, automatic control may be implemented where it was not previously possible.

Novatech oxygen probes use advanced zirconia cell technology developed by the CSIRO Division of Materials Science and Technology. For further information, contact Novatech Controls (Aust) Pty Ltd, 429 Graham St, Port Melbourne, Vic 3207. Phone (03) 9645 2377 or fax (03) 9646 3027.

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- FMTX10 $599: a complete FMTX5 built and tested, enclosed in a quality case with plugpack, DIN input connector for audio and a 1/2mtr internal antenna, also available in 1U rack mount with balanced cannon input sockets, dual VU meter and BNC RF $1299. Ideal for cable FM or broadcast transmission over distances of up to 300 mtrs, i.e. drive-in theatres, sports arenas, football grounds up to 50mW RF out.
- FMTX10B $2599: same as rack mount version but also includes dual SCA coder with 67 & 92kHz subcarriers.

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- DIGI-125 Audio Power Amp: this has been the most popular kit of all time with some 24,000 PCBs being sold since 1987. Easy to build, small in size, high power, clever design, uses KISS principle. Manufacturing rights available with full technical support and PCB CAD artwork available to companies for a small royalty. 200 Watt Kit $29, PCB only $4.95.
- AEM 35 Watt Single Chip Audio Power Amp $19.95: this is an ideal amp for the beginner to construct; uses an LM1875 chip and a few parts on a 1 inch square PCB.
- Low Distortion Balanced Line Audio Oscillator Kit $69: designed to pump out line up tone around studio complexes at 400Hz or any other audio frequency you wish to us. Maximum output +21dBm.
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- Universal BALUN Balanced Line Converter Kit $69: converts what you have to what you want, unbalanced to balanced or vice versa. Adjustable gain. Stereo.

COMPUTERS

- Max I/O Card for PCs Kit $169: originally published in Silicon Chip, this is a real low cost way to interface to the outside world from your PC, 7 relays, 8 TTL inputs, ADC & DAC, stepper motor drive/open collector 1 amp outputs. Sample software in basic supplied on disk.
- IBM PC 8255 24 Line I/O Card Kit $69, PCB $39: described in ETI, this board is easy to construct with only 3 chips and a double sided plated through hole PCB. Any of the 24 lines can be used as an input or output. Good value.
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- All-In-One 486SLC-33 CPU Board $799: includes dual serial, games, printer floppy & IDE hard disk drive interface, up to 4Mb RAM 1/2 size card.
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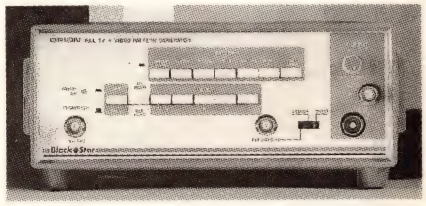
KITS-R-US sell the entire range of designs by Graham Dicker. The designer has not extended his agreement with the previous distributor, PC Computers, in Adelaide. All products can be purchased with Visa/Bankcard by phone and shipped overnight via Australia EXPRESS POST for $6.80 per order. You can speak to the designer Mon-Fri direct from 6-7pm or place orders 24 hours a day on: PH 018 80 6794; FAX 08 270 3175.

Pattern generator for TV & computer monitors

Obiat Pty Ltd has introduced the Black Star 1410 video monitor tester, a microprocessor controlled instrument for aligning and testing computer and TV monitors and video projectors. The comprehensive range of line and frame frequencies, together with a variety of rear panel outputs, ensures compatibility with most monitors.

The Black Star 1410 produces a wide range of test patterns which includes a testcard, raster, vertical and horizontal lines, colour bars, checkerboard, dots and a focus function. The selected pattern, system, sync polarity and line/frame frequencies are shown on the unit's liquid crystal display. It is suitable for CGA, MDA, PGA, VGA, SVGA and 8514A/XGA computer displays in addition to TV monitors. Factory-programmed versions of the 1410 are also available.



For more information, contact Obiat Pty Ltd, 129 Queen St, Beaconsfield, NSW 2014. Phone (02) 698 4111 or fax (02) 699 9170.

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April 1989: Auxiliary Brake Light Flasher; What You Need to Know About Capacitors; 32-Band Graphic Equaliser, Pt.2; LED Message Board, Pt.2.

May 1989: Build A Synthesised Tom-Tom; Biofeedback Monitor For Your PC; Simple Stub Filter For Suppressing TV Interference; LED Message Board, Pt.3; All About Electrolytic Capacitors.

July 1989: Exhaust Gas Monitor (Uses TGS812 Gas Sensor); Extension For The Touch-Lamp Dimmer; Experimental Mains Hum Sniffers; Compact Ultrasonic Car Alarm.

September 1989: 2-Chip Portable AM Stereo Radio (Uses MC13024 and TX7376P) Pt.1; High Or Low Fluid Level Detector; Studio Series 20-Band Stereo Equaliser, Pt.2; Auto-Zero Module for Audio Amplifiers (Uses LMC669).

October 1989: FM Radio Intercom For Motorbikes Pt.1; GaAsFet Preamplifier For Amateur TV; 1Mb Printer Buffer; 2-Chip Portable AM Stereo Radio, Pt.2; Installing A Hard Disc In The PC.

November 1989: Radfax Decoder For Your PC (Displays Fax, RTTY & Morse); FM Radio Intercom For Motorbikes, Pt.2; 2-Chip Portable AM Stereo Radio, Pt.3; Floppy Disc Drive Formats & Options; The Pilbara Iron Ore Railways.

December 1989: Digital Voice Board (Records Up To Four Separate Messages); UHF Remote Switch; Balanced Input & Output Stages; Data For The LM831 Low Voltage Amplifier IC; Index to Volume 2.

January 1990: High Quality Sine/Square Oscillator; Service Tips For Your VCR; Speeding Up Your PC; Phone Patch For Radio Amateurs; Active Antenna Kit; Speed Controller For Ceiling Fans; Designing UHF Transmitter Stages.

February 1990: 16-Channel Mixing Desk; High Quality Audio Oscillator, Pt.2; The Incredible Hot Canaries; Random Wire Antenna Tuner For 6 Metres; Phone Patch For Radio Amateurs, Pt.2.

March 1990: 6/12V Charger For Sealed Lead-Acid Batteries; Delay Unit For Automatic Antennas; Workout Timer For Aerobics Classes; 16-Channel Mixing Desk, Pt.2; Using The UC3906 SLA Battery Charger IC.

April 1990: Dual Tracking ±50V Power Supply; Voice-Operated Switch (VOX) With Delayed Audio; 16-Channel Mixing Desk, Pt.3; Active CW Filter For Weak Signal Reception; How To Find Vintage Receivers From The 1920s.

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July 1990: Digital Sine/Square Generator, Pt.1 (Covers 0-500kHz); Burglar Alarm Keypad & Combination Lock; Simple Electronic Die; Low-Cost Dual Power Supply; Inside A Coal Burning Power Station.

August 1990: High Stability UHF Remote Transmitter; Universal Safety Timer For Mains Appliances (9 Minutes); Horace The Electronic Cricket; Digital Sine/Square Wave Generator, Pt.2.

September 1990: Remote Control Extender For VCRs; Power Supply For Burglar Alarms; Low-Cost 3-Digit Counter Module; Simple Shortwave Converter For The 2-Metre Band.

October 1990: Low-Cost Siren For Burglar Alarms; Dimming Controls For The Discolight; Surfsound Simulator; DC Offset For DMMs; The Dangers of Polychlorinated Biphenyls; Using The NE602 In Home-Brew Converter Circuits.

November 1990: How To Connect Two TV Sets To One VCR; A Really Snazzy Egg Timer; Low-Cost Model Train Controller; Battery Powered Laser Pointer; 1.5V To 9V DC Converter; Introduction To Digital Electronics; Simple 6-Metre Amateur Transmitter.

December 1990: DC-DC Converter For Car Amplifiers; The Big Escape – A Game Of Skill; Wiper Pulser For Rear Windows; Versatile 4-Digit Combination Lock; 5W Power Amplifier For The 6-Metre Amateur Transmitter; Index To Volume 3.

January 1991: Fast Charger For Nicad Batteries, Pt.1; Have Fun With The Fruit Machine; Two-Tone Alarm Module; LCD Readout For The Capacitance Meter; How Quartz Crystals Work; The Dangers When Servicing Microwave Ovens.

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March 1991: Remote Controller For Garage Doors, Pt.1; Transistor Beta Tester Mk.2; A Synthesised AM Stereo Tuner, Pt.2; Multi-Purpose I/O Board For PC-Compatibles; Universal Wideband RF Preamplifier For Amateur Radio & TV.

April 1991: Steam Sound Simulator For Model Railroads; Remote Controller For Garage Doors, Pt.2; Simple 12/24V Light Chaser; Synthesised AM Stereo Tuner, Pt.3; A Practical Approach To Amplifier Design, Pt.2.

May 1991: 13.5V 25A Power Supply For Transceivers; Stereo Audio Expander; Fluorescent Light Simulator For Model Railways; How To Install Multiple TV Outlets, Pt.1.

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December 1991: TV Transmitter For VCRs With UHF Modulators; Infrared Light Beam Relay; Solid-State Laser Pointer; Colour TV Pattern Generator, Pt.2; Index To Volume 4.

January 1992: 4-Channel Guitar Mixer; Adjustable 0-45V 8A Power Supply, Pt.1; Baby Room Monitor/FM Transmitter; Automatic Controller For Car Headlights; Experiments For Your Games Card; Restoring An AWA Radiolette.

February 1992: Compact Digital Voice Recorder; 50-Watt/Channel Stereo Power Amplifier; 12VDC/240VAC 40-Watt Inverter; Adjustable 0-45V 8A Power Supply, Pt.2; Designing A Speed Controller For Electric Models.

March 1992: TV Transmitter For VHF VCRs; Studio Twin Fifty Stereo Amplifier, Pt.1; Thermostatic Switch For Car Radiator Fans; Telephone Call Timer; Coping With Damaged Computer Directories; Valve Substitution In Vintage Radios.

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September 1992: Multi-Sector Home Burglar Alarm; Heavy-Duty 5A Drill speed Controller (see errata Nov. 1992); General-Purpose 3½-Digit LCD Panel Meter; Track Tester For Model Railroads; Build A Relative Field Strength Meter.

October 1992: 2kW 24VDC To 240VAC Sinewave Inverter; Multi-Sector Home Burglar Alarm, Pt.2; Mini Amplifier For Personal Stereos; Electronically Regulated Lead-Acid Battery Charger.

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February 1993: Three Simple Projects For Model Railroads; A Low Fuel Indicator For Cars; Audio Level/VU Meter With LED Readout; Build An Electronic Cockroach; MAL-4 Microcontroller Board, Pt.3; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.5.

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June 1993: Windows-Based Digital Logic Analyser, Pt.1; Build An AM Radio Trainer, Pt.1; Remote Control For The Woofer Stopper; Digital Voltmeter For Cars; Remote Volume Control For Hifi Systems, Pt.2

July 1993: Build a Single Chip Message Recorder; Light Beam Relay Extender; AM Radio Trainer, Pt.2; Windows Based Digital Logic Analyser; Pt.2; Quiz Game Adjudicator; Programming The Motorola 68HC705C8 Microcontroller – Lesson 1; Antenna Tuners – Why They Are Useful.

August 1993: Low-Cost Colour Video Fader; 60-LED Brake Light Array; A Microprocessor-Based Sidereal Clock; The Southern Cross Z80-based Computer; A Look At Satellites & Their Orbits.

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November 1993: Jumbo Digital Clock; High Efficiency Inverter For Fluorescent Tubes; Stereo Preamplifier With IR Remote Control, Pt.3; Siren Sound Generator; Electronic Engine Management, Pt.2; More Experiments For Your Games Card.

December 1993: Remote Controller For Garage Doors; Low-Voltage LED Stroboscope; Low-Cost 25W Amplifier Module; Build A 1-Chip Melody Generator; Electronic Engine Management, Pt.3; Index To Volume 6.

January 1994: 3A 40V Adjustable Power Supply; Switching Regulator For Solar Panels; Printer Status Indicator; Mini Drill Speed Controller; Stepper Motor Controller; Active Filter Design For Beginners; Electronic Engine Management, Pt.4.

February 1994: 90-Second Message Recorder; Compact & Efficient 12-240VAC 200W Inverter; Single Chip 0.5W Audio Amplifier; 3A 40V Adjustable Power Supply; Electronic Engine Management, Pt.5; Airbags – How They Work.

March 1994: Intelligent IR Remote Controller; Build A 50W Audio Amplifier Module; Level Crossing Detector For Model Railways; Voice Activated Switch For FM Microphones; Simple LED Chaser; Electronic Engine Management, Pt.6.

April 1994: Remote Control Extender For VCRs; Sound & Lights For Model Railway Level Crossings; Discrete Dual Supply Voltage Regulator; Low-Noise Universal Stereo Preamplifier; Build A Digital Water Tank Gauge; Electronic Engine Management, Pt.7.

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June 1994: 200W/350W Mosfet Amplifier Module; A Coolant Level Alarm For Your Car; An 80-Metre AM/CW Transmitter For Amateurs; Converting Phono Inputs To Line Inputs; A PC-Based Nicad Battery Monitor; Electronic Engine Management, Pt.9

July 1994: SmallTalk – a Tiny Voice Digitiser For The PC; Build A 4-Bay Bow-Tie UHF Antenna; PreChamp 2-Transistor Preamplifier; Steam Train Whistle & Diesel Horn Simulator; Portable 6V SLA Battery Charger; Electronic Engine Management, Pt.10.

August 1994: High-Power Dimmer For Incandescent Lights; Microprocessor-Controlled Morse Keyer; Dual Diversity Tuner For FM Microphones, Pt.1; Build a Nicad Zapper; Simple Crystal Checker; Electronic Engine Management, Pt.11.

September 1994: Automatic Discharger For Nicad Battery Packs; MiniVox Voice Operated Relay; Image Intensified Night Viewer; AM Radio For Aircraft Weather Beacons; Dual Diversity Tuner For FM Microphones, Pt.2; Electronic Engine Management, Pt.12.

October 1994: Dolby Surround Sound – How It Works; Dual Rail Variable Power Supply (±1.25V to ±15V); Talking Headlight Reminder; Electronic Ballast For Fluorescent Lights; Temperature Controlled Soldering Station; Electronic Engine Management, Pt.13.

November 1994: Dry Cell Battery Rejuvenator; A Novel Alphanumeric Clock; 80-Metre DSB Amateur Transmitter; Twin-Cell Nicad Discharger (See May 1993); Anti-Lock Braking Systems; How To Plot Patterns Direct To PC Boards.

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January 1995: Build A Sun Tracker For Solar Panels; Battery Saver For Torches; Dolby Pro-Logic Surround Sound Decoder, Pt.2; Dual Channel UHF Remote Control; Stereo Microphone Preamplifier; The Latest Trends In Car Sound; Pt1.

February 1995: 50-Watt/Channel Stereo Amplifier Module; Digital Effects Unit For Musicians; 6-Channel Thermometer With LCD Readout; Wide Range Electrostatic Loudspeakers, Pt.1; Oil Change Timer For Cars; The Latest Trends In Car Sound; Pt2; Remote Control System For Models, Pt.2.

March 1995: 50W/Channel Stereo Amplifier, Pt.1; Subcarrier Decoder For FM Receivers; Wide Range Electrostatic Loudspeakers, Pt.2; IR Illuminator For CCD Cameras & Night Viewers; Remote Control System For Models, Pt.3; Simple CW Filter.

April 1995: Build An FM Radio Trainer, Pt.1; Photographic Timer For Darkrooms; Balanced Microphone Preamplifier & Line Filter; 50W/Channel Stereo Amplifier, Pt.2; Wide Range Electrostatic Loudspeakers, Pt.3; 8-Channel Decoder For Radio Remote Control.

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August 1995: Vifa JV-60 2-Way Bass Reflex Loudspeaker System; A Fuel Injector Monitor For Cars; Gain Controlled Microphone Preamp; The Audio Lab PC Controlled Test Instrument; The Mighty-Mite Powered Loudspeaker; An Easy Way To Identify IDE Hard Disc Drive Parameters.

PLEASE NOTE: November 1987 to August 1988, October 1988 to March 1989, June 1989, August 1989, May 1990, November 1992 and December 1992 are now sold out. All other issues are presently in stock. For readers wanting articles from sold-out issues, we can supply photostat copies (or tearsheets) at $7.00 per article (includes. p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge.

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Controller for G-scale electric loco

I am writing to you regarding building a speed control for a G-scale electric train. I have a 7W solar panel connected to a bank of 10 nicad batteries from which I would like to run the train. The whole system has to be in DC current (input and output) and every control I've seen is a combination of AC/DC which does not operate satisfactorily. The control also needs to have a forward/reverse switch. Do you have a suitable circuit? (G. O., Carine, WA).

• Our most successful train controller, a walk-around throttle design published in April & May 1988, could be run from a supply rail of between 17V and 20V DC. Using 10 nicad cells, you would be starting with a supply rail of 12V which is not really sufficient for this design.

If you wish to use only 12V, the most effective design would be the simple DC speed control published in our February 1993 issue. Both the articles referred to have been reprinted in our "14 Model Railway Projects" book which is available from us at $7.95 plus $3 for postage.

By the way, if you are using a 12V solar panel to charge your 10 nicad batteries, it is unlikely that they will ever be fully charged and hence their effective service life is likely to be very short. To properly charge a 10-cell nicad battery pack, you need a charging voltage of more than 18V. We plan to publish a fast charger for nicads, running from a 12V car battery, in the coming October 1995 issue.

Reducing current drain of Door Minder

Your Door Minder project in the July edition is a very novel idea. However, I estimate the current draw of this circuit to be around 8-10mA and not really suitable for batteries. Besides, why do you use hard to get (expensive) IGFET transistors (BS 170)? Can they be substituted by enhancement-mode Mosfets (25K679N) or perhaps J-FETs (MPF-102) etc?

Is it feasible to make the following modifications to lower consumption: (1) deletion of the 7808 regulator; (2) use of a 5V reference diode for the bias-voltages for IC1; (3) switching off the power rail to IC3 when not used via transistor. Could it be modified to work with sliding-doors and how? (M. S., Edgewater, WA).

• Your estimate of current drain is about right and is really too much for a battery operated device. That is why we specified a 12V plugpack.

While you could modify the circuit along the lines you suggest, the greatest economy would be obtained by substituting a TL062 for the TL072 and shutting down the LM386 when no signal is present. However, the latter modification would require more circuitry.

Charger for deep cycle batteries

I have a question regarding deep cycle batteries. I have an 85 amp-hour deep cycle battery that is used to power an electric outboard motor. How should this type of battery be charged and how can I tell when it's fully charged? Can I use the SLA battery charger published in the August 1992 issue? If so, where can I obtain a kit of parts? (C. W., Middle Park, Qld).

• Your deep cycle battery could be charged with the SLA battery charger although at its maximum setting it would take many hours to charge a flat 85 amp-hour battery. As far as we know, kits for this project are no longer available but you can purchase the PC board from RCS Radio Pty Ltd, phone (02) 587 3491.

We hope to publish a higher capacity charger for conventional lead acid batteries, sometime in the next three or four months.

Fun with the weather beacon radio

I recently bought a Dick Smith kit to make your LF weather beacon AM radio, as featured in the September 1994 issue. Wiring the components once assembled into the case was a bit fiddly, especially wiring the leads to the RF and Volume pots. However, it all came together in the end, including my own modification of a headphone socket that mutes the speaker when using headphones.

The radio worked first try but at

LED temperature gauge for a motorcycle

I need some information on making a LED readout temperature gauge for an Enduro motorcycle. I have the temperature sender. Does anyone make kits? The LEDs need to be approx. 40mm long. Also, I'd like some information on a LED tacho 0-14,000rpm firing at once every 360° (single cylinder 2-stroke) and twice very 360° (twin cylinder 2-stroke). (P. S., Parap, NT).

• A suitable circuit for a temperature gauge LED readout was published in the February 1994 issue of SILICON CHIP on page 45. It was for reading the output from an oxygen sensor but a temperature sensor could also be used if a 4.7kΩ resistor is connected between the 12V supply and input at pin 5.

A LED Digital Tachometer was published in the August 1991 issue of SILICON CHIP. For the single cylinder 2-stroke, use 180kΩ for Rx while the twin 2-stroke will require 82kΩ for Rx. Calibration using the 50Hz signal for the single cylinder engine is for a reading of 3000 rpm; for the twin, use 1500 rpm.

first I was disappointed in its performance. However, it is 50 years since I last used a TRF set and now I have got the "feel" of it, I have had quite surprising results. My best reception so far is "WON", the Non-Directional Beacon at Wonthaggi, just over 110km away on the coast just south-east of Port Phillip Bay. I also receive Melbourne Radio Coastal Shipping station at excellent strength, on 500kHz and 430kHz, located 90km away.

The only problem I have is a continual background of programmes from the two ABC stations on 621kHz and 774kHz, regardless of the setting of the tuning control. The stations are 18 to 20km away. I can minimise the babble by rotating the radio so that the ferrite rod is "end-on" to the stations but the background babble is still there. Despite this, I can receive eight NDBs which is good going for a TRF set with no external antenna. I did try coupling a long wire antenna to the set but the BC breakthrough rendered it useless.

I would be interested to know if the original set, used in Penrith, suffered from broadcast band breakthrough, or am I just unlucky in being close to the Melbourne stations? (J. S., Glenroy, Vic).

• You should not suffer from broadcast band breakthrough with this design. One point to watch is to keep the wires from the ferrite rod to the PC board as short as possible and together. This will minimise direct pick-up on the antenna wires.

The ferrite rod must also not be too close to the PC board or to any surrounding metalwork. You may be able to improve the performance of your set by using a larger ferrite antenna.

Source for solid state vibrators

In the August 1995 issue, a reader asked about obtaining vibrators or the use of a solid state replacement. Replacement vibrators are obtainable through the many vintage radio restorers in NSW and Victoria, such as "Resurrection Radio" of 242 Chapel Street, Prahran, Victoria 3151, phone (03) 9510 4486. They come in a variety of voltages and, in their latest parts list, were listed at $35.

At that price the solid state device looks very attractive, unless you are a stickler for authenticity, but maybe someone will find a way to fit the device into the case of an old vibrator to maintain the look of originality. (B. W., Caulfield North, Vic).

Command control for model railways

Over the years, I have followed with interest the various model railroad projects you have published. I have purchased a copy of "14 Model Railway Projects" and found it useful. Have you considered some projects based on the Digital Command Control system being adopted by the NMRA in the US? Public domain plans are available for stand-alone and computer controlled systems. I am very interested in moving to this form of control but lack the expertise to transform the basic circuits into an operating design, although I am capable of building the kits from the resulting plans.

I don't know how much interest there would be in such projects but I am convinced it is a very practical system, particularly for new layouts. I would also like to see some notes on how your previous projects, such as the train detector in the June 1995 issue, would operate with a command control system. (G. S., Esperance, WA).

• We are aware of these developments but are concerned that the receivers to be installed in locos would require surface mount components which would be a big obstacle for most model railway enthusiasts. The overall cost could be a problem too, apart from the considerable development cost for such a project.

The detector published in the June 1995 issue of SILICON CHIP should work with command control systems, without any modifications.

Diagram for Audiosonic cassette recorder

Do you, or any of your readers, know where I might be able to obtain the schematic diagram for the Audiosonic AM/FM stereo radio dual cassette recorder, which has item code 715 790, and part number WKC9558E? The stereo is virtually all black in colour, and would be about 5-7 years old. Does anybody know where I can get the book entitled "Microprocessor Data Handbook", 3rd Edition, which is published by Micro Tech? Jaycar Electronics did sell this item but have since run out. (P. Fullagar, 6 Highfield St, Mayfield, NSW 2304).

Digital display for AM/FM radio

I have bough a GE Superadio which is supposed to be very good at receiving medium wave broadcasts. It has medium wave and FM reception. Unfortunately, it is an analog model. It has no VU meter or anything else. I want to have a VU meter and digital readout installed in it, either LED or LCD. As there does not seem to be any room on the radio for such additions, I suppose that it will have to be installed in a "zippy" box with wiring leading to the radio.

Is such a project possible? (J. G., Runaway Bay, Qld).

• Quite a lot of circuitry is required to add a digital readout to any conventional radio, particularly if it covers the AM broadcast and FM bands. In both cases, the circuitry must measure the local oscillator in the radio and then subtract the intermediate frequency to find the station frequency.

We have not published a suitable circuit and would hazard a guess that if we did, the resulting kit could easily cost $150 or more. Nor is there any guarantee that your radio would have internal access to the local oscillators – they may be buried inside a large integrated circuit and thus the job may not be feasible at all.

LCD capacitance meter jitter

I have put together a capacitance meter as described in the January 1991 issue. All ranges operate correctly except for the pF range. Here I experience an instability of the last digit. It remains steady for two or three updates and then it changes. The differ-

Headphone amplifier for PA system

After reviewing your recent articles on the 50W Stereo Amplifier (Feb-April 1995) and looking at my version of the 120W PA amplifier (Nov. 1988 to Jan. 1989), which has four microphone inputs and a line output for a tape recorder or power amplifier, I would like to add a headphone amplifier.

This would function in the same way as it does in your 50 watt stereo amplifier, having normally the audio signal feeding the output socket for the line output, but when the headphone jack (mono) is inserted, the signal is diverted to the headphone amplifier.

Can the circuitry used in the 50W Stereo Amplifier for the headphone amplifier be used for this project? What alterations will have to be done? And lastly, what are the power supply requirements for the headphone amplifier?

Please note the headphone amplifier will only need to be mono, not stereo. (R. T., Mundubbera, Qld)

• The headphone amplifier in the 50W Stereo Amplifier should work without problems. If you need to increase the gain you can do so by reducing the 10kΩ resistor connected to pin 6(2) of IC3a. The required supply voltage is ±15V DC. This can be derived in the same way as the existing low voltage supply rails in the 120W PA amplifier; ie, via 680Ω 5W dropping resistors and 15V 3-terminal regulators.

ence can be as high as 8pF. I am convinced that the synchronous coupling between the free running IC1 and the bistable IC2 is at fault. There may have been others who have experienced the same trouble and have been able to rectify the malfunction.

I would also like to ask for a concise explanation, maybe from one of your readers, on how the "LCD A/D converters-display drivers" activate the correct segments in the LCD when they are bundled up in groups; ie agd, bc and ef respectively. (K. B., Forestville, NSW).

• Jitter in the last digit of the display could be attributed to the changes in output levels of IC1 and IC2 occurring at different times. These can affect the power supply rails which can slightly alter the timing sequence and thus the capacitance reading.

The PC board design should be carefully checked for correct ground track layout so that current loops are not formed. The board pattern for the original design using LED displays can be seen in the May 1990 issue, where star point earthing was used. This design did not have problems with jitter on the pF range.

Each segment of an LCD is driven entirely separately. They are not bundled together as in a multiplexed display. A "lit" or visible segment occurs when the signal applied to it is 180 degrees out of phase to the backplane. When the applied signal is in phase with the backplane, the segment is off.

How to design an electromagnet

Could you please give me a simple formula to calculate the ampere turns necessary for a home made electromagnet or solenoid for various battery operated gadgets? For example, I wish to make an electromagnet or solenoid to operate a camera which requires 250 gram pressure on the trigger to operate. Hope this is in your field. (D. H., Mosman, NSW).

• Unfortunately, we cannot help you directly since the design involves not just the ampere-turns produced by the coil but also the details of the magnetic circuit as well. This involves the type of steel and design of the laminations, the design of the plunger and its return spring, if required. The driving circuit must also be taken into account because many solenoids are designed to be energised momentarily; if energised continuously they will quickly overheat and burn out.

Your camera solenoid application is one requiring considerable power and would also need to be a momentary design otherwise it would be physically quite large. Having noted all of the above, why not try winding several hundred turns of fine gauge wire onto a bobbin which is a close fit over a 1/4-inch bolt? Energised with a 6V lantern battery, this should provide quite a reasonable degree of thrust. At the very least, it will provide a starting point.

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Notes & Errata

Fuel Injector Monitor, August 1995: the specified LM358 op amp has been found to be non-linear in the circuit at low and high injector duty cycles. The problem is corrected by substituting an RCA CA 3260E op amp which has CMOS outputs. This op amp is a drop-in replacement but a change to the integration RC network at pin 3 is desirable. Change the 4.7kΩ resistor to 47kΩ and the 220µF capacitor to 10µF. **SC**

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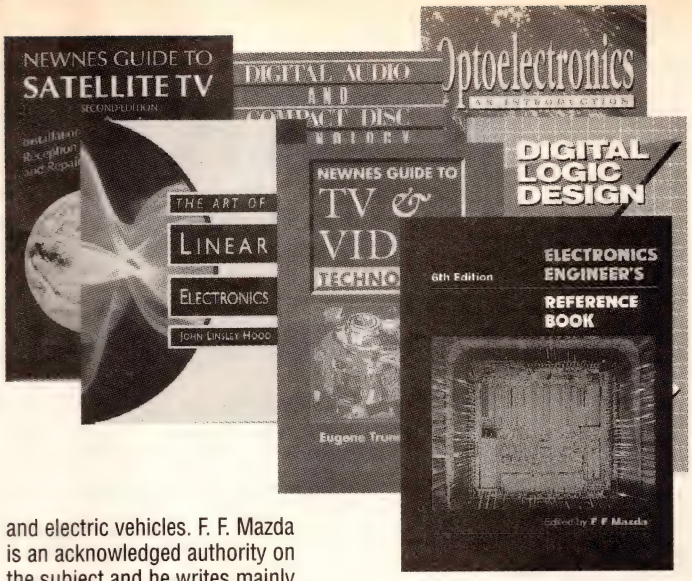

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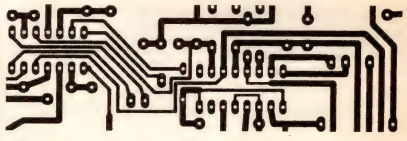

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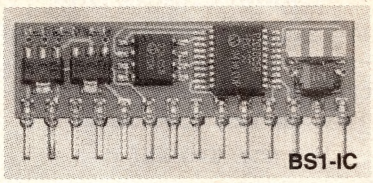

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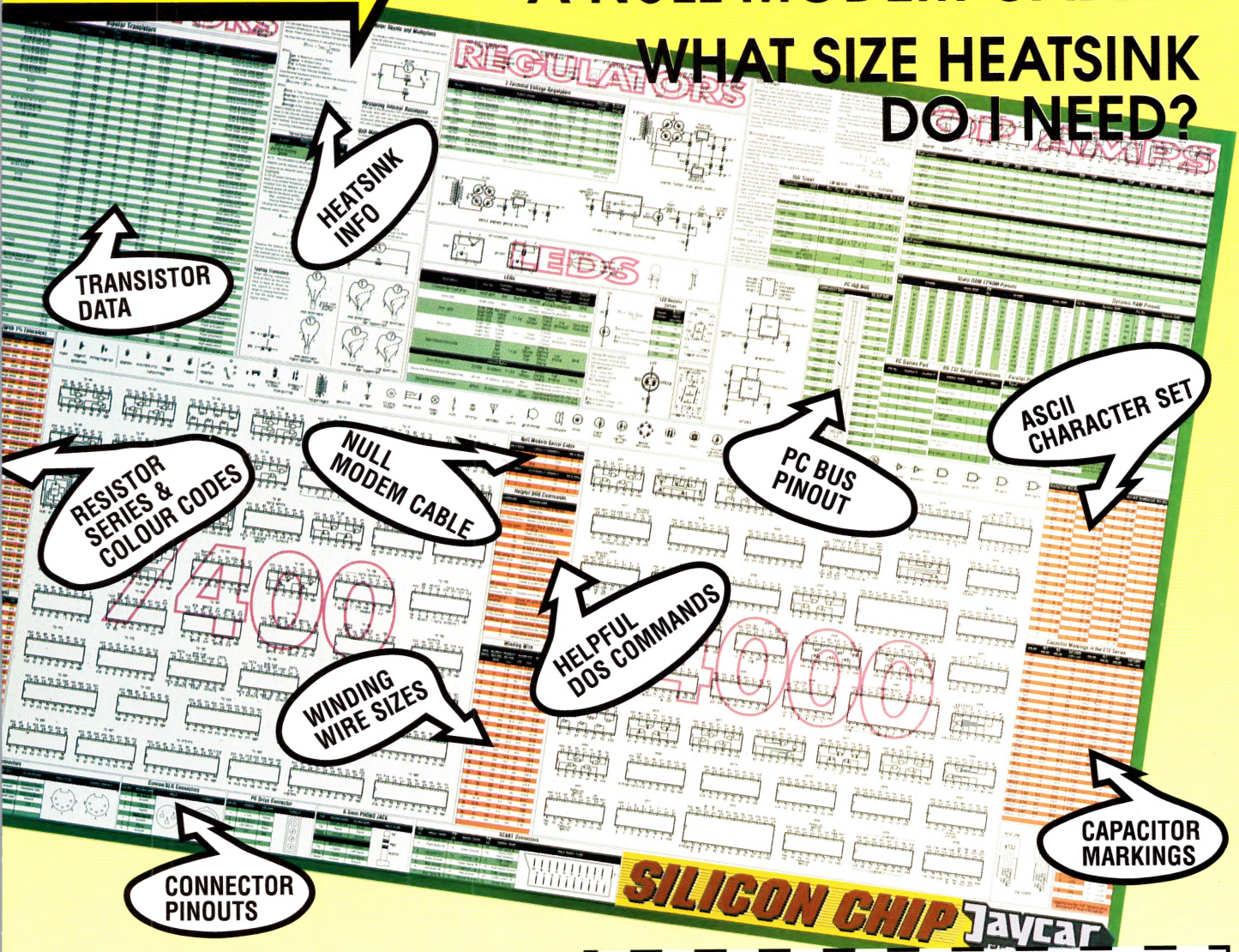

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